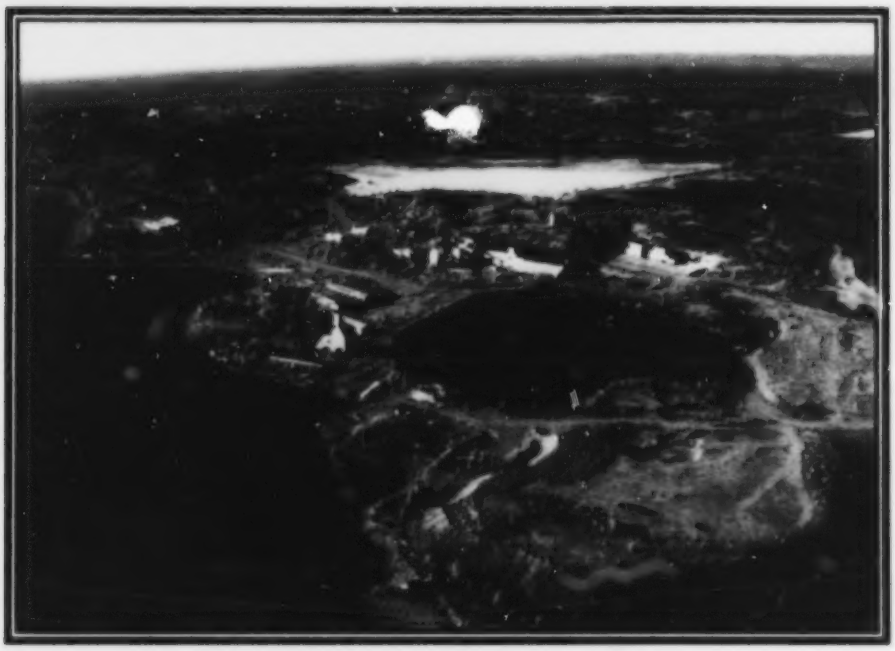
GUNNAR
&
LORADO

2002-2003 UPDATE



Prepared on behalf of:
Saskatchewan Northern Affairs
Government of Saskatchewan

Prepared by:
KHS Environmental Management Group Ltd.

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1.0 INTRODUCTION

1.1 Reason for Submission

This document has been prepared by the Government of Saskatchewan in support of a planned February 2004 meeting of the Canadian Nuclear Safety Commission (CNSC) to review the status of activities surrounding idle uranium mines in Canada. Saskatchewan and the CNSC share a common interest in seeing the decommissioning and reclamation of certain former uranium mine/mill sites in northern Saskatchewan undertaken in a timely fashion by appropriate responsible authorities.

This report provides a brief summary of the developmental and operational history of two former uranium production facilities in northern Saskatchewan: the Lorado Uranium Mining Ltd. mill site and the Gunnar Mining Ltd. mine, mill and associated facilities. Both facilities are located near Uranium City in the northwest corner of the Province of Saskatchewan. The results of Saskatchewan's recent due diligence analysis on the current disposition of the Lorado mine/mill site forms the basis of a specific recommendation to the CNSC on 'next steps' that could be undertaken toward the preparation of a decommissioning plan for the Lorado site.

The report also updates recent Saskatchewan actions - especially those activities related to the address of public safety risks - related to the two principal sites, particularly Gunnar. The report draws upon available data and recent observations to provide an initial characterization of the Gunnar site, its features, current conditions and risk assessments.

Finally, the report broadly overviews the rationale underpinning, and the results of, Saskatchewan's most recent efforts in 2003 to re-engage the Government of Canada in negotiations that would result in an appropriate, cost-shared, partnership approach to the decommissioning of these former uranium mine/mill sites.

1.2 Overview – Lorado and Gunnar Sites

The Lorado Uranium Mining Ltd. mill was commissioned in May 1957 and processed ore from its own mine as well as from various small uranium mines in the area until April 1960. Mill tailings from the processing of the uranium ores were originally deposited in a small 'pot hole' at the west end of Nero Lake, which eventually overflowed and entered Nero Lake itself. Approximately 335,000 tons of tailings eventually entered Nero Lake and approximately 14 hectares of tailings remained above the high water line exposed to both water and wind erosion on the west side of Nero Lake. The water level in Nero

Lake was initially raised when the operator created a dyke on a narrow isthmus between Nero and Beaverlodge Lakes. The dyke elevation was further raised in 1959 and remains in place today.

No decommissioning or reclamation was undertaken at the Lorado Uranium Mining Ltd. mill site when the mill ceased operations in April 1960, however the mill building itself was decommissioned in 1990 by A. Frame Contracting Ltd. under contract to Conwest Exploration Ltd. At that time, no decommissioning or rehabilitation was undertaken on the exposed tailings, Nero Lake itself or on the dyke between Nero and Beaverlodge Lakes.

The Gunnar Mining Ltd. mine, mill and associated facilities are located on the southern tip of the Crackingstone Peninsula approximately 25 kilometres southwest of Uranium City. The Gunnar facilities were constructed between 1953 and August 23rd 1955 when the mill commenced production. The mining of the Gunnar open pit ceased in 1961, at which time ore feed to the mill was entirely replaced by ore generated from the underground mine. The average grade of ore at the Gunnar Mining Ltd. mine was approximately 0.175% U_3O_8 as finely disseminated pitcheblende and uranophane, in syenite containing about 8% calcite and 2-3% hematite (BBT, 1986).

Currently, as well as during operations, the site is/was only accessible by boat/barge in the summer, over the ice in the winter or by a small gravel airstrip approximately 3 kilometres north of the mine site.

Because of the remote location, the Gunnar site was self-contained and provided housing for all single and married employees. The site also had its own school (Grade 1-10 with approximately 100 students) a seven-bed hospital with a doctor, matron and three registered nurses, a large community centre that included a Hudson's Bay Store, a Post Office, a branch of the Canadian Imperial Bank of Commerce, a coffee shop, dining room, bakery, butcher shop, beauty salon, large auditorium, bowling alley, pool room, games room, lounge, library, club rooms and radio broadcasting room.

Underground mining of the Gunnar ore body ceased in October 1963 as the ore body was considered depleted and the entire facility ceased operations, officially closing in 1964.

The mill tailings and other aqueous wastes generated by operations were initially discharged into a small lake located 500 m to the north of the mill (Ruggles et al., 1978) that is referred to in historical documentation as either Blair Lake or Mudford Lake. This area is currently referred to as the Gunnar Main Tailings.

The Gunnar Main Tailings basin eventually filled with tailings solids and a small rock outcrop was blasted to allow the tailings to flow from the Main area to a small depression referred to as Gunnar Central Tailings. Once this relatively small basin was filled, the tailings continued to flow downhill, eventually entering Langley Bay, Lake Athabasca.

During operations, a sufficient volume of tailings was discharged and allowed to flow into Langley Bay so as to eventually cut Langley Bay into two separate portions: one which is still connected by a narrow channel to Lake Athabasca proper and a smaller 'back bay' which has intermittent connection to Langley Bay itself.

No decommissioning or reclamation was undertaken either before or after the Gunnar Mining Ltd. facilities officially closed.

A body of research literature exists on the environmental conditions at both the Gunnar and Lorado sites. Initial study of the sites began in 1978 and a large portion of the research has been completed on the Gunnar Mining Ltd. Site. This available information is important in its applicability to both sites because of their close proximity and similarity in environmental conditions.

In 1984 and 1985, the Gunnar Mining Ltd. site was the subject of an extensive investigation resulting in a nine-volume report prepared by a group of consultant firms under the auspices of the National Uranium Tailings Program. The report presents the results of studies related to characterizing the tailings material, ground and surface waters, and the biological and atmospheric environs at the Gunnar Mining Ltd. site.

Other work since 1978 includes investigations into the limnology of the flooded pit at the Gunnar Mining Ltd. site, contaminant levels in fish from Langley Bay, as well as natural revegetation of the tailings areas and revegetation trials, to list a few.

In 1989, Beak Consultants were commissioned by Saskatchewan Environment and Public Safety to review available environmental data, engineering documents and publications on the Gunnar and Lorado facilities, abstract all of the relevant data and to conduct a pathway analysis and identify the environment and public safety risks posed by the two sites. The work was published in a report entitled *An Evaluation of Potential Environmental and Public Safety Impacts of the Gunnar and Lorado Facilities in Northern Saskatchewan.*

None of the above work concentrated on the development of a conceptual decommissioning or rehabilitation plan for the sites. Instead, the work has concentrated on the theoretical environmental science regarding what is actually taking place regarding various physical parameters on the sites.

1.3 Submitted By

The Office of Northern Affairs has coordinated the preparation of this document on behalf of the Government of Saskatchewan. All inquiries related to the document or the status of planned activities related to the sites themselves should be directed to:

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Given the complexities involved, the long histories associated with these former operating uranium mine/mill sites, and current international protocols and precedents guiding actions vis-à-vis such sites in other countries, the Government of Saskatchewan has adopted a corporate approach in the management of this file. This ensures appropriate consideration and coordination of all legal, regulatory, technical, financial and other aspects related to negotiations with federal authorities concerning the eventual remediation of the sites and any provincial activities undertaken with regard to the sites.

Specifically, implementation of Saskatchewan's strategy to realize the proposed decommissioning and reclamation of the sites is being managed by a Deputy Ministers' Steering Committee chaired by Executive Council. Provincial departments represented on the Committee include: Executive Council, Saskatchewan Northern Affairs, Saskatchewan Justice, Saskatchewan Industry & Resources, Saskatchewan Environment and Saskatchewan Governmental Relations. Saskatchewan Finance also participates, as required. The Steering Committee is supported by a technical working group of officials – a Project 'Core Group.'

The Deputy Ministers' Steering Committee offers overall strategic direction in attempting to advance Saskatchewan's interests in the remediation of these former uranium mine/mill sites. The Saskatchewan Cabinet will make all final decisions regarding any Saskatchewan commitments related to the file.

1.4 The Document

Section 2 of this document provides a discussion of the Lorado Uranium Mining Limited mill site and includes a discussion of the site location, history, current disposition as well as a brief summary of current site facilities. The section also includes a discussion of the proposed installation of additional warning signs near the Lorado Uranium Mining Ltd. mill property by March 2004.

Section 3 provides a similar discussion of the Gunnar Mining Limited site and includes descriptions of the site location, history, current disposition and a summary of the facilities still in existence on the site. The section also contains a discussion of site activities undertaken by the Government of Saskatchewan, with a particular emphasis on the past year (2003). The section concludes with a brief discussion of existing environmental and public safety issues at the site.

Section 4 provides a summary of conclusions in relation to both sites.

Section 5 provides a summary of negotiations to date between the Government of Saskatchewan and the Government of Canada regarding the issue of funding any required actions on the former uranium facilities in northern Saskatchewan.

2.0 LORADO URANIUM MINING LTD. MILL SITE

2.1 Site Location

The Lorado Uranium Mining Ltd. mill site is located at 59^0 31' 11'' N, 109^0 48' 06" W north of Lake Athabasca in the northwest corner of Saskatchewan (Figure 2.1.1). The mill site is approximately 8 km south-southwest of Uranium City (Figure 2.1.2) on the western shore of a Nero Lake (Figure 2.1.3). A bedrock ridge that forms the western edge of the Nero Lake watershed basin delineates the western edge of the mill site. As a result, all shallow subsurface and surface flows from the mill site, as well as from the deposited tailings on the site, flow to Nero Lake.

Although Nero Lake is referred to as a 'lake' in most documentation, it has no permanent inflow or outflow (Beak, 1989). Any discharges from Nero Lake flow into Hanson Bay of Beaverlodge Lake, which in turn discharges to Martin Lake. Martin Lake discharges to Cinch Lake, which discharges via the Crackingstone River to the Crackingstone Inlet of Lake Athabasca.

A total of 121 people live within 80 kilometres of the Lorado Uranium Mining Ltd. mill site. According to Saskatchewan Northern Municipal Services, as of November 2003, Uranium City, which is located approximately 8 kilometres north-northeast of the mine site had a total population of 84 permanent and part-time residents and Camsell Portage, located approximately 35 kilometres northwest of the mine site, had a total population of 37 residents (Figure 2.1.2).

The Lorado Uranium Mining Ltd. mill site is easily accessed from Uranium City by an all weather gravel road that branches off the provincial gravel road (#962) between Uranium City and Bushell Bay.

The provincial road is maintained by Saskatchewan Highways and Transportation. However, the spur that travels over the Lorado property to the former Box mine site has recently (2003) been posted as "Not Maintained."

2.2 Site History

The Lorado Uranium Mining Ltd. mill was designed and constructed to process ore from the company's mine and to custom treat ore from a number of other small uranium mines in the area that, because of their limited ore production, could not justify the establishment of their own independent milling facilities.

The Lorado Uranium Mining Ltd. mill was located approximately 6.5 kilometres from the Lorado Uranium Mining Ltd. mine and was chosen for its centralized location with respect to neighbouring mines. The mill was originally designed to process 500 tons of ore per day when it was commissioned in May 1957. In October 1957, capacity of the facility was increased to 750 tons per day.

The original mill was designed as a sulphuric acid leach process with the acid being supplied by the in-house processing of pyrite from the company mine. Soon after start-up, however, the mill developed a number of difficulties including a shortage of acid, water supply contamination and ore-processing problems.

The high-carbonate character of the custom ore processed at the mill consumed approximately twice as much sulphuric acid as originally anticipated. As a result, the original sulphuric-acid manufacturing plant was enlarged and converted from a pyrite process to a direct sulphur-burning process in August 1958.

During its first year of operation, the Lorado mill treated 134,112 tons of uranium ore, or approximately 367 tons per day - well below its design capacity. The tailings (and other liquid wastes) from this activity were deposited untreated at pH 1.7 to 2.0, into a small lake at the west end of Nero Lake (Beak, 1989). This small lake was soon filled and the tailings flowed into Nero Lake itself.

When the mill was originally designed and commissioned, it was proposed to use water from Nero Lake as the water supply while at the same time depositing the tailings into the west end of the lake. As Nero Lake has no permanent inflow or outflow and a small watershed, it was assumed that there would be little change in the water levels of the lake. However, because the tailings were deposited untreated into the lake at a pH of between 1.7 and 2.0, by 1958, Nero Lake itself was acidic and had a high chloride content (Beak, 1989). As a result, by mid-1958, the Lorado mill had developed a severe corrosion problem throughout the mill that required the company to change its fresh water source from Nero to Beaverlodge Lake. This was accomplished on October 5, 1958 by the installation of a 4000 ft. long pipeline from Beaverlodge Lake to the mill.

This action had a significant effect on the water balance of Nero Lake as the majority of the water withdrawn from Beaverlodge Lake was subsequently being deposited in Nero Lake in the form of tailings and other liquid effluent discharges from the mill. As the inflow to Nero Lake increased, a concern that the dyke separating Nero Lake from

Beaverlodge Lake would overtop led to a decision in 1959 to raise the level of the dyke (Beak, 1989).

In addition to its own ore, Lorado Uranium Mining Ltd. negotiated contracts to custom process ore from a number of different uranium mines in the area. These included, but were not necessarily limited to, ores from: Consolidated Beta Gamma Mines, Cayzor Athabasca Mines Limited, Lake Cinch Mines Limited, National Explorations Limited, Rix-Athabasca Uranium Mines Limited, Black Bay Uranium Limited and St. Michael's Uranium Mines Limited (Beck, 1969).

During the operations of the Eldorado Mining and Refining Ltd. Beaverlodge mill and associated mines, ore owned by Eldorado was also milled at the Lorado Uranium Mining Ltd. mill. A review of historical records has, to date, identified two ore bodies owned by Eldorado that were milled at the Lorado mill. These ore bodies contributed to the tailings at the Lorado site.

One such property is the Eagle Lake ore body (Mineral property #1360, Showing Name: Eagle Uranium Mine) located near Shaft Lake, south of Melville Lake. This ore body was first prospected in 1947. Initial development of the mine began in 1950. A total of 103,408 tonnes of ore were shipped from this mine to the Lorado mill for processing. This returned a total of 223,574 kg of refined uranium (U_3O_8) to Eldorado Mining and Refining Ltd. (Sask., 2001)

A similar property was the Martin Lake adit, which was collared on the shores of Martin Lake by Eldorado in 1948 in order to investigate mineralization located west of Beaverlodge Lake. In 1952, a second collar was driven from the Beaverlodge Lake side to connect with the original Martin Lake adit. Eldorado closed the mine in 1954 because production levels were considered insufficient to justify continuous operations. However, in 1959, an arrangement was made between Eldorado Mining and Refining Ltd. and Lorado Uranium Mining Ltd. to have Lorado mine and mill 278 tonnes of ore from the adit (MacLaren, 1983).

The Lorado Uranium Mining Ltd. mill ceased operations in April 1960. By that time, approximately 335,000 short tons of tailings had entered Nero Lake and approximately 14 hectares of tailings remained above the water line on the west side of Nero Lake (Beak, 1989) (Photo Plate 1 and Fig. 2.1.4).

2.3 Existing Facilities

2.3.1 Decommissioned Mill

No decommissioning or reclamation was undertaken at the site when the mill ceased operations in April 1960, however the mill facility itself was decommissioned in 1990 by A. Frame Contracting Ltd. under contract to Conwest Exploration Company Ltd. At that time, no decommissioning or rehabilitation was undertaken on the exposed tailings, Nero Lake, or the dyke between Nero and Beaverlodge Lakes. As a result, approximately 335,000 tons of tailings remain in Nero Lake and approximately 14 hectares of tailings remain above the water line on the west side of Nero Lake exposed to both water and wind erosion.

During an assessment of abandoned mines in the area in 2001, an accumulation of scrap steel, product barrels etc. was discovered approximately 10 m off the road at 59^0 30.319' N, 108^0 42.215' W or 1.5 kilometres south of the Lorado Uranium Mining Ltd. mill site (Photo Plate 2). The area is approximately 45 m long by 20 m wide. The material is piled approximately 1 to 2 m high and consists of various debris and scrap metal; ore barrels, piping, machinery, etc. with residual fines or chemicals in a number of barrels. Gamma levels measured within the waste disposal site ranged from background (0.07 - 0.23 μS/h) to 5.56 μS/h at 1 m height (SERM, 2001). The exact source of this material has not yet been positively confirmed. However, based on the material present, the site appears to be a waste disposal area used during either the operation or the decommissioning of the Lorado mill. The size of resident vegetation at the location would seem to indicate the latter.

2.3.2 Nero Lake Containment Dyke

In July 2001, Saskatchewan retained the services of SRK Consulting Engineers and Scientists to undertake an inspection of the isthmus separating Nero and Beaverlodge Lakes. On September 11, 2001 a representative of SRK conducted an inspection and provided a letter to Saskatchewan Environment on October 17, 2001 that summarized the results of the inspection and provided recommendations in relation to the observed conditions.

That letter report indicated that the physical stability of the road/dam did not appear to be at risk in terms of foundation failures and that, although seepage through the roadway/dam is occurring, the risk of piping failure appeared to be low based on the materials and the low head involved (SRK, 2001).

The letter report did, however, raise a concern with regards to overtopping, indicating that the current condition and size of the culvert does not ensure peak flood events can be

reliably and safely passed from Nero Lake to Beaverlodge Lake. As a result, there is a significant risk that the roadway/dam can be overtopped, which may lead to rapid down cutting of the roadway/dam and the discharge of a large volume of acidic water into Beaverlodge Lake (SRK, 2001).

2.4 Proposed Installation of Warning Signs

During November 2003, Saskatchewan commissioned the printing of additional warning signs similar to those installed earlier in the year at the Gunnar Mining Ltd. site. Six 4-foot by 4-foot signs provide a graphic, as well as Dene and English text, warning of the potential risk posed by radiation at the Lorado mill site and urge that passers-by 'do not enter' the area.

The signs have been transported to Uranium City and are being mounted. The signs will be erected early in the new year on provincially-controlled lands that border the property, with a particular emphasis on those areas on both sides of the gravel road that traverses the Lorado site.

2.5 Disposition

2.5.1 Ownership

In 2001, the Contaminated Lands Evaluation and Assessment Network (CLEAN) Program was established by the Canadian Nuclear Safety Commission (CNSC) to deal with sites previously not licensed under the *Atomic Energy Control Act*, but which are now not exempt from licensing under the *Nuclear Safety and Control Act* (NSCA) (CNSC, 2001). One category of such sites includes tailings management sites resulting from the historic operations of former uranium mines. Documentation prepared by CNSC staff state that *"some of these tailings management sites were previously exempted from licensing because they are in the care and control of provincial or federal government agencies, and the Atomic Energy Control Act was not binding on the Crown. Others were not licensed because their operational lives ended before the Atomic Energy Control Board began exerting regulatory control on the uranium mining industry"* (CNSC, 2001).

CNSC staff also stated that the Gunnar and Lorado sites are considered abandoned and that the care and control of the sites had reverted to the Province of Saskatchewan (CNSC, 2001). Based on this, the CNSC staff requested that the Province bring a license application to the Commission or a Designated Officer for decision by December 31, 2004.

The Government of Saskatchewan has conducted a detailed investigation of the current legal disposition of the Lorado mill site in order to fulfill necessary due diligence requirements. During the course of this investigation, Saskatchewan conducted a title search of the property. That search disclosed that, in 1970, title to the property was granted to International Mogul Mines Limited, a successor of Lorado Uranium Mining Ltd. A copy of that title and the current titles registered in the name of Conwest Exploration Company Limited, a successor to International Mogul Mines Ltd., is set out in Appendix A. Conwest Exploration Company Limited was succeeded by AEC West Ltd. which, subsequently, changed its name to EnCana West Ltd. A copy of the results of a search of the Alberta Corporate Registration System and an extract from EnCana's website is attached in Appendix B.

The owner of the Lorado mill site is not the Government of Saskatchewan, but EnCana West Ltd.

2.5.2 Eldorado Mining and Refining Ltd.

The required due diligence investigation of both the company (Lorado) and the operations of its mill also confirmed that ore owned by Eldorado Mining and Refining Ltd. was milled at the Lorado Uranium Mining Ltd. mill. A review of historical records has, to date, identified two ore bodies owned by Eldorado Mining and Refining Ltd. that were milled at the Lorado mill and, hence, contributed to the tailings currently existing at the Lorado mill site.

Prior to 1944, Eldorado Mining and Refining Ltd. was a privately held corporation, incorporated under the laws of Ontario. However, on January 28, 1944, by Order-in-Council PC535, it became a federal Crown corporation, incorporated under the *Dominion Companies Act (1934)* (Bothwell, 1984). Therefore, at the time the ore from Eldorado was being processed at the Lorado mill, Eldorado Mining and Refining Ltd. was a federal Crown corporation.

2.5.3 Conclusion

Based on this information, Saskatchewan believes the CNSC staff's request that the Province of Saskatchewan bring a license application for the Lorado Uranium Mining Ltd. mill site to the Commission, for decision by December 31, 2004, is misdirected.

Saskatchewan suggests that the Canadian Nuclear Safety Commission pursue EnCana West Ltd. as the current registered owner of the Lorado mill site. In addition, Saskatchewan suggests that the Canadian Nuclear Safety Commission and/or Environment Canada pursue the Government of Canada to accept responsibility for the remediation of wastes created at the Lorado site by the custom milling of ore from

Eldorado Mining and Refining Ltd. The custom milling of Eldorado ore at the Lorado site also contributed to the generation of the tailings that are currently the subject of the licensing action by the CNSC.

3.0 GUNNAR MINING LIMITED SITE

3.1 Site Location

The former Gunnar Mining Limited site is located at 59^0 23' N, 108^0 53' W midway along the north shore of Lake Athabasca in the northwest corner of Saskatchewan, approximately 725 kilometres north of Prince Albert (Figure 2.1.1).

Lake Athabasca is the 22nd largest lake in the world (by area) and the eighth largest lake in Canada. It has an estimated surface area of 8,080 km^2 and a maximum depth of approximately 124 m (Gleick, 1993). Lake Athabasca drains north to the Arctic Ocean via the Slave and MacKenzie Rivers.

The site is located on the southern tip of the Crackingstone Peninsula approximately 25 kilometres southwest of Uranium City (Figure 3.1.2). During operations, the site was only accessible by boat/barge in the summer and over the ice in the winter. As well, during operations, Gunnar Mining Limited maintained a small gravel airstrip approximately 3 kilometres north of the mine site. It was used to transport personnel and light freight to and from the site. Most heavy freight was delivered by barge from the railhead at Waterways, Alberta during the summer or open water season. The airstrip now provides air access to a tourist lodge located on an island south of the St. Mary's Channel and south of the mine site itself.

A total of 121 people live within 80 kilometres of the Gunnar Mining Limited site. According to Saskatchewan Northern Municipal Services, as of November 2003, Uranium City, which is located approximately 25 kilometres north of the mine site had a total population of 84 permanent and part-time residents and Camsell Portage, located approximately 37 kilometres northwest of the mine site, had a total population of 37 (Figure 3.1.2). The only access either community has to the Gunnar Mining Limited site is by boat during the open water season or over the ice during the winter as there is no road access from either community.

Figure 3.1.2 shows three additional communities: Lorado, Eldorado and Bushell. These three communities no longer exist. As of 2002, there were no permanent residents in any of the three communities.

3.2 Site History

Gunnar Mining Limited was incorporated as Gunnar Gold Mines Limited in October 1933 with an Ontario Charter. As such, it operated a gold mine at Beresford Lake, Manitoba from 1933 until 1942.

The Gunnar uranium deposit in northern Saskatchewan was discovered in July 1952 when two prospectors identified frost-heaved boulders in a muskeg area close to the shores of St. Mary's Channel, Lake Athabasca. After staking and initial prospecting, 11 inclined drill holes were put down and indicated a widespread pitchblende-bearing zone in the bedrock immediately beneath the muskeg. The deposit was subsequently delineated by an additional 179 vertical holes drilled on a 75-foot grid pattern for a total of approximately 70,000 feet. This drill program outlined an ore body of approximately 450 ft in diameter, plunging from surface to a depth of approximately 1,000 ft below the surface elevation of nearby Lake Athabasca. The ore body was originally estimated to contain 4 million tons of ore grading 0.19 – 0.20 % U_3O_8.

With the discovery of the Beaverlodge area uranium deposit and with the company's activities extending to uranium and chromium, in addition to gold, the name of the company was thought to be misleading and was changed to Gunnar Mines Limited (Botsford, 1963). On December 1st, 1960, Gunnar Mines Limited and Nesbitt Labine Uranium Mines Limited were amalgamated to become Gunnar Mining Limited.

The Gunnar uranium deposit property was comprised of two Development Areas, as defined by the *Saskatchewan Mineral Disposition Regulations*, 1961, the first containing 35 claims covering 1423 acres, and the second containing 19 claims covering an area of 827 acres.

The Gunnar ore body was a saucer-like ore body that could, at least initially, be mined by open pit without going underground. In addition the deposit was 25 kilometres from Uranium City and therefore geographically isolated enough to justify the construction of its own milling facility. On March 11, 1954, a contract was signed which obligated Gunnar to supply 8,100,000 pounds of U_3O_8 to Eldorado Mining and Refining Ltd. between 1955 and 1960 at a specified price. As required by the Atomic Energy Control Board, all sales were to be made to Eldorado Mining and Refining Ltd. and only Eldorado, which then signed an identical contract with the US Atomic Energy Commission for sale of product (Bothwell, 1984).

Mining Permits, MP2/54 (issued September 16, 1954 by the Atomic Energy Control Board) and MP 2/57, (issued February 1, 1957 by the Atomic Energy Control Board) specified that Gunnar Mines Limited was authorized:

> *"to carry on development, mining, milling and concentrating operations on the property hereunder mentioned and to ship ore and/or concentrates there from to Eldorado Mining and Refining Limited (hereinafter called "Eldorado") in accordance with such arrangements as may from time to time be in effect between you and Eldorado."* (MP2/54, 1954, MP2/57, 1957)

Early drilling results had suggested that the ore body was pinching out at approximately 450 ft and the production planning completed in 1953 assumed an open pit mine providing enough feed to supply a 750-ton per day mill. However, additional drilling proved that the ore body extended to a further depth than anticipated and an expansion of the production facility was warranted. A revised plan was developed that increased the milling capacity from 750 to 1250 tons per day. To meet the targeted production date, it became evident that overburden removal from the open pit and rock removal required for the construction of the mill, acids plant and powerhouse sites would have to commence in early 1954, prior to the date that the required heavy equipment could be brought in by barge.

Because of the remote location, the Gunnar site was self-contained and provided housing for all single and married employees. During operations, the site also had its own school (Grade 1-10 with approximately 100 students) a seven bed hospital with a doctor, matron and three registered nurses, a large community centre that included a Hudson's Bay Store, a Post Office, a branch of the Canadian Imperial Bank of Commerce, a coffee shop, dining room, bakery, butcher shop, beauty salon, large auditorium, bowling alley, pool room, games room, lounge, library, club rooms and radio broadcasting room.

Photo Plate 3 provides a current aerial view of the various facilities remaining at the Gunnar Mining Limited site. Figure 3.1.3 indicates the approximate topographic distribution of facilities at the site.

Open Pit Mine Development and Operation

The open pit was 1000 feet (304 m) long in a north south direction and 800 feet (244 m) wide. The final depth was 380 feet (116 m), which was 360 feet (110 m) below Lake Athabasca surface levels. The upper walls of the pit were generally mined in granite gneiss.

The north wall of the pit followed closely the footwall of the ore body resulting in the bulk of waste rock being produced from a large crescent-shaped mass in the south end of the pit decreasing in size with depth. The rock was mined in 30-foot vertical benches leaving a 21-foot berm on each bench. As a result, the wall angle was approximately 55^0 except were modified by haulage roads (Photo Plate 4).

This pit design required that a substantial tonnage of ore in the south wall of the pit be lost to pit mining and left for recovery from underground. When experience proved the walls to be very competent, particularly on the south side of the pit, the design was modified to permit the removal of the berms on this side on the lowest five benches of the pit. As a consequence, the south wall of the pit was left as a vertical face for a height of approximately 150 feet. This modification, plus the removal of a bottom bench below original design specifications, improved the overall waste:ore ratio from 2.48:1 to 1.83:1.

The open pit was located very close to the shores of Lake Athabasca with the rim of the pit separated from Lake Athabasca by a bedrock ridge approximately 2m wide and 6 m long. In spite of this close proximity to the lake and the fact that the pit extended to a depth of approximately 116 m, there was little in the way of subsurface flow from the lake to the pit or to the underground workings of the mine. During 1963 when underground development below the pit bottom essentially reached the maximum depth, pumping from underground averaged only 75 gallons per minute, which included the ingress of water from backfilling with tailings (Botsford, 1963).

Mining of the open pit ceased in 1961, at which time ore feed to the mill was entirely replaced by ore generated from the underground mine.

Underground Mine Development and Operation

Preparation of the underground mine began in 1955, although ore from the open pit was the main mill feed until 1959. Between 1959 and 1961 the mill was supplied with a combination of ore from both the open pit and the underground.

Surface rock excavation for the head frame, bin house, shaft collar and temporary hoist room was completed in the summer of 1955 and the shaft was then sunk by Gunnar mine crews to open eight underground levels and allowed to fill with water while the permanent surface facilities were completed. Lateral underground development was not started until June 1957.

The first ore was produced from underground in 1957 and production was increased, as necessary, until 1961 when the open pit was exhausted and the underground began to supply all of the mill ore feed.

Some historical documentation indicates the existence of a raise in addition to the main shaft while other documentation shows a raise only into the bottom of the now flooded pit. Additional investigations are required to confirm the exact location of the raise if it exists and where it came to surface.

Underground mining of the Gunnar ore body ceased in October 1963 as the ore body was considered depleted.

The Mill

Design of Gunnar's 1250-ton a day mill was started in October 1953 and the ordering of structural steel and major equipment was essentially completed by August 1954. Excavation, concrete work, steel erection, building siding and roofing, and equipment

installation were completed by August 23rd 1955 and the mill commenced production on that date. The first drum of precipitate was produced on September 9, 1955.

The design of the mill building and the acid plant site provided for the possibility of expansion and the installation of additional equipment was completed in March 1957. Major items of this expansion included the installation of a 42-inch gyratory crusher, two leach agitators, three string discharge drum filters, an Eimco precoat drum filter and the construction of an additional acid plant at a 65 ton per day capacity. These additions increased the mill's initial rated capacity of 1250 tons per day to 1650 tons per day. This capacity itself was exceeded with the mill achieving 2000 tons of ore processed per day in July 1958 and continuing at that rate until at least July 1963.

The mill treatment plant circuit was divided into two separate production lines of the same capacity from the evenly split rod-mill discharge to the packing of the precipitate. This allowed metallurgical information to be obtained on a plant-scale basis and also provided enough flexibility to maintain a high percentage of production in the event of a serious breakdown, lack of material or other unforeseen causes. The following provides a brief discussion of one of the two separate circuits. Figure 3.2.1 provides a schematic of the milling circuit at the Gunnar Mining Limited site.

The ball-mill discharge from crushing was maintained at 69% solids, classifier overflow at 39% solids and 45% minus 200 mesh, which was then discharged to a splitter box feeding the thickeners.

Thickening: There were two 50 ft. diameter by 23 ft. high, three-compartment, steel tank thickeners. The thickener overflow from both production lines was collected in a 20 ft. diameter, 30 ft. high steel tank and returned to the grinding circuit. Backwash solution from the ion exchange circuit was added as required. Thickener underflow, at 60% solids, was discharged by means of suction pumps and no flocculants were used in the thickener feed.

Leaching: Moved by gravity, the thickened pulp flowed to a six-inch airlift and was elevated to the No. 1 leaching agitator. This leaching feed was automatically sampled and the pulp flowed in a series through seven wood stave leaching tanks with stainless steel agitators. Six of the leach tanks were 20 ft. in diameter by 25 ft. high and one was 20 ft. in diameter by 20 ft. high. Approximately 70 cubic feet per minute of air was consumed in each leach tank with agitation being provided by a central airlift and two air jets on the agitator rakes. The addition of sulphuric acid to the No. 1 leach agitator was automatically controlled to maintain a pH of 1.7 and in all other leach tanks, pH was recorded on a strip chart with additional acid added manually when required to maintain pH 1.7.

The 93% sulphuric acid was delivered to each leach tank by gravity flow from a header system in which manual valves made of alloy were used. An oxidizing agent in the form

of a 25% solution of sodium chlorate was added manually to the No. 1 leach tank in amounts sufficient to maintain a slight excess of oxidant. Retention time in the leaching circuit totalled 24 hours.

Filtration: The leached pulp was drawn from the bottom of the seventh leach tank, which served as a surge tank, and was pumped to a four-way splitter box above the primary acid filters. Two-stage filtration was completed using four string-discharge drum filters, each equipped with a wooden deck and 316 stainless steel ends, and four string discharge filters with a steel drum covered with Linatex. A filter aid in the form of ¼ % solution of 'jaguar' gum was added to the feed supplied to both filtration stages.

The primary filter cake was washed with water and then re-pulped to 57% solids (with water) and then pumped to a four-way splitter box over the secondary filters. The secondary cake discharge was again re-pulped with water to 57% solids and flowed to the tailings disposal tank. The combined primary and secondary filtrate was then pumped to the clarification thickener.

Clarification: In the first stage of filtrate clarification, a 30 ft. diameter by 20 ft. high wood stave thickener with stainless steel mechanisms was used. A ½ % solution of glue was added as a flocculant to the thickener feed and the settled solution was drawn from the thickener once per day and returned to the leach circuit. The overflow from one production line was passed through a 5 by 7 ft. leaf clarifier with 50 leaves and employing 'supercel' as a precoat material. The other production line employed an 8 ft. diameter by 14 ft. long, 60% submergence precoat drum filter as a clarifier and supercel was used as the precoat material. The clarified pregnant solution from each clarifier was pumped to a 30 ft. diameter by 20 ft. high wooden stave storage tank where the pH was automatically adjusted to 1.7 before entering the ion-exchange circuit.

Ion-exchange: Each ion-exchange production line consisted of four 7 ft. by 14 ft. columns containing 285 $ft.^3$ of 'IRA 400' resin. The pregnant solution passed down flow through two of the columns in series where the uranium was selectively absorbed by the resin and exchanged with chloride ions already adsorbed to the resin. The common impurities, with the exception of ferric iron, were not adsorbed and passed through the resin bed. The discharge or effluent from the second column contained all the impurities as well as chloride ions that were replaced by uranium and this barren material was discharged to the tailings tank. When the first column had adsorbed as much uranium as possible, the adsorption phase was stopped and the column was taken from the circuit for removal of the uranium by elution. The second column in the series became the first column and a fresh column was brought on stream (as the second column) and the new adsorption phase started.

The fully adsorbed column was then placed in a two-stage elution process. In the first stage, a recycle solution composed of 1 Normal sodium chloride and 0.1 Normal sulphuric acid, was passed through the resin. In the passage, the chloride ions in the

recycle solution were adsorbed on the resin and replaced the uranium. The effluent carried five times the uranium concentration of the pregnant solution and was sent to precipitation.

In the second stage of the elution process, the small amount of uranium remaining on the resin was removed by a fresh brine solution consisting of a 1 Normal sodium chloride and 0.1 Normal sulphuric acid mixture. The effluent from this stage was then sent to a 16 ft. diameter by 20 ft. high wood stave storage tank to be used as recycle solution.

Precipitation: Precipitation was carried out in two 16 ft. diameter by 20 ft. high wood stave tanks equipped with double paddle agitators. Magnesia ground to 90% minus 200 mesh was slurried with water to 25% solids and then circulated to the precipitation tanks on an hourly basis. The batch stage was completed at a neutral pH and was completed in eight hours after which the precipitated uranium was delivered to the precipitation filters.

Product Filtration: Filtration of the precipitate was accomplished on both production lines by the use of three 36-inch wash type, plate and frame filter presses. The yellowcake was washed with water to bring impurities below contracted specifications. After a 60-minute treatment with warm, low-pressure air blown through, the yellowcake, which still contained 50 to 60% moisture, was discharged to a receiving hopper. A batch filtration cycle was completed in seven to nine hours.

The barren filtrate was returned to a pump box where salt was added manually to obtain a 1 Normal sodium chloride solution that was then pumped to a make-up tank identical to the precipitation tank. In this tank, 93% sulphuric acid was added manually to produce a 0.1 Normal acid solution. This salt-sulphuric acid solution, referred to as fresh brine, was then discharged to a 20 x 20 ft. wood stave storage tank for further use in the ion-exchange elution.

Drying and Packaging: From the receiving hopper, the yellowcake was deposited through a stainless steel chute to a dryer beneath the filter. The moisture content was reduced to 6% in a steam-jacketed, 10 ft. diameter, revolving sweep dryer for eight hours. The dried precipitate was then elevated pneumatically with a fan to a 6 ft. tall, 125 ft^3 bag filter storage hopper. From storage, a drum load of precipitate was delivered by a vibrating feeder to the weigh hopper with attached scale and placed in drums with the dust created in the packing cabinet being removed and recovered.

The steel drums used to ship the product to Edmonton had a capacity of 25 gallons. Packed drums were flown out to Edmonton by either Eldorado Aviation Limited or Gunnar Nesbitt Aviation Limited.

Chemical Mixing: A chemical mixing area inside the mill building housed the equipment necessary for the preparation and storing of the jaguar and glue solutions used in the milling process. The dissolution and storage tanks for these chemicals were wooden

stave type equipped with mixers. The chemicals were delivered to various areas of the mill by pumping them through a header system.

Sodium chlorate solutions were prepared in a separate building with the use of a concrete dissolving pit, aluminium storage tanks and pumps to deliver the solution through the header system to the leach tanks.

Tailings Disposal: Tailings were collected in a 20 ft. diameter, 7.5 ft. high wooden stave tank equipped with a single paddle mixer and were disposed of as 32% solids through a 1,500 ft. long, 10 in. diameter wooden stave pipe. In 1958, the mill installed a cyclone plant in order to use a portion of the tailings as sand backfill for the underground mine.

Acid Plant: Sulphuric acid was manufactured on site by the conventional contact process by means of a vanadium mass catalyst. Two plants rated at 100 tons and 64 tons per day of 100% sulphuric acid were built. The plants were similar in design but had one common section located in the 100-ton plant for the melting and filtering of sulphur and supplied both plants with molten elemental sulphur. The elemental sulphur used in the plants was transported by barge to the site from southern Alberta.

The acid produced by the plants was stored in two 32 ft. high 40 ft. diameter insulated steel tanks located behind the mill. Each tank had a capacity of 1,500 tons and acid flowed to the mill header system by gravity.

Laboratories: The analytical laboratories consisted of a floor area of approximately 3,000 ft.^{2} and were located in the front of the mill, and included room for mill test work as well as an instrument repair shop.

Freshwater Intake: The freshwater supply was taken directly from Lake Athabasca and pumped to a 200,000 gal. tank located on the hill immediately behind the mill. During 1963, the daily requirement for water was approximately 3,200,000 gallons.

Fuel: Approximately 11,000 tons of bulk petroleum per year were delivered during the open water season to the Gunnar Mining Limited site in order to fulfill the annual requirements for heavy diesel fuel, light diesel oil and gasoline. In total, the site had storage capacity for 1,890,000 gallons of fuel.

Power Generation: All the required power generation for the Gunnar facilities was produced in the power house which measured 104 by 202 ft. and contained seven 1200 hp diesel engines direct-coupled to 2300 volt, 60 cycle, 3-phase generators, and all high and low pressure compressor and vacuum pumps required to operate the mill.

Production: Table 3.2.1 provides a summary of available data for production at the Gunnar Mining Limited facility. During its peak year, 1958, milling capacity was increased to 2,000 tons of ore per day in order to handle the ore from both the open pit

and the underground mine. The average ore recovery during 1961 was 95.5% producing a uranium precipitate which consisted of 76% U_3O_8.

The average grade of ore at the Gunnar Mining Ltd. mine was approximately 0.175 % U_3O_8 as finely disseminated pitcheblende and uranophane, in syenite containing about 8% calcite and 2-3% hematite (BBT, 1986).

The Gunnar site officially closed in 1964.

3.3 Existing Facilities

3.3.1 Facility Buildings

The following provides a brief discussion of the facilities still in existence on the Gunnar Mining Limited site. Figure 3.3.1 is a reproduction of a site map originally produced in 1961 by Gunnar Mining Limited and provides an identification of buildings still present on the site.

Utilidors

Throughout the site, remnants can be found of above-ground utilidors which appear to have connected all of the buildings on the site. During operations, these would have carried the water, sewage and steam used for heating. A typical utilidor contains 2 - 1" steel piping, 1 - 2" steel piping, 1 - 4" steel piping - all enclosed in a wooden frame insulated with fibreglass insulation and located atop a trestle when required. There is very little underground piping on the site. However, there is an area on the west side of the pit between the mill mechanical shop and the head frame where there is evidence of buried piping, the total extent of which is unknown.

Head Frame

The head frame covers an area 120 ft. by 76 ft. and is on a reinforced-concrete foundation wall pinned to bedrock. It has a total height of 157 ft. and is sheeted with asbestos siding. The entire interior was insulated with spray on asbestos fibre.

The original mine shaft consisted of an 11 ft. 8 in. by 6 ft. cage compartment, a 5 ft. 6 in. by 6 ft. skip compartment and a 5 ft. 6 in. by 6 ft. man way and was sunk to a depth of 1,905 ft. (580 m). Currently, the shaft has a concrete cap of undetermined thickness. Three, 4-inch vents are visible in the cap.

The floor of the head frame and shaft house is covered with old wooden crates and various steel objects, including engine parts. There were no chemicals located in the head frame.

The stairwell, which ascends to the top of the head frame, appeared to be in a relatively safe condition. However, the top level of the head frame is a safety hazard, as the siding has been damaged and there are no railings of any sort. As a result, 2003 site safetying activities cut the stairway to prevent any access to the upper levels of the head frame, and the head frame and shaft house itself were wrapped with 8 ft. high chainlink fence to prevent unauthorized entry.

A 76 ft. by 48 ft bin house is incorporated in the head frame and contains two 1,000-ton storage bins. There is no residual ore in either of the bins and very little scrap material scattered on the floor in this area. No chemicals were found.

The shaft house is 76 ft. by 67 ft. and was built within the structural "A" of the head frame.

A short distance to the west is a concrete foundation and various scrap steel. This would appear to have been the location of the hoist.

Mill

The mill is of structural steel construction and is 550 ft. long by 160 ft. wide. The roof ranges between 40 and 80 ft. in height. The mill building was sheeted with asbestos. The main building was not insulated. The laboratory areas, which are on the south side of the main building, were insulated with spray-on asbestos which was then painted.

At some time in the past, perhaps to facilitate previous salvage operations, portions of the mill roof were removed to allow light to enter.

In total, the mill building houses ore bins, the crushing plant, milling circuits and laboratories.

There are two annex buildings which house a 1,000-ton and a 200-ton ore bin and which were fed by and discharged to the mill building proper by conveyers. Both of these buildings are asbestos sheeted. In the 1,000-ton Bin Annex there is a man-way connected to the mill along the conveyor.

Working from west to east through the mill:

Crushing Grinding Area – the crushers have been removed from the crushing plant as have the Marc ball mills. In both areas, there remain large volumes of reinforced concrete.

Five, 1,000-ton ore bins are in place, as is the supporting steel for the conveyers under the ore bins. Some salvage has taken place in all of these areas and the stairways are in various stages of disrepair.

Milling Circuit - Four, 50 ft. diameter by 23 ft. deep thickener tanks are supported on steel "I" beam legs approximately 7 ft. off the floor. All the tanks have been previously emptied and hatchways have been left open.

The roof to the northeast of the thickeners has collapsed to some extent; however, the reason is not obvious. In one area, there is a block of concrete approximately 1 cubic yard in size that has fallen to the floor. There is also evidence of other material dropping on the stairwells in the same area.

The majority of the leaching circuit has been salvaged at some point in the past and all that remains are three of the original 14 leach tanks. The three remaining tanks (20 ft. diameter by 20 ft. high) are complete; all that remains of the others are the steel "I" beams which were used as supports.

Fifteen string filter units are located on the upper level at the eastern end of the mill building. There are also four wood-stave clarithickeners, two Whitco Leaf clarifiers and an Eimco precoat filter.

The floor level below the string filters consists of a single wood-stave tank contained within a concrete berm approximately 7 feet deep. There is evidence that water has accumulated within this berm.

There are two 16 ft. by 16 ft. wood-stave surge tanks intact and empty.

The milling circuit then flowed to the south side of the mill building where the ion exchange and precipitation circuits are located. There are 2 brine tanks (20 ft. by 20 ft.), two recycle tanks (16 ft. by 20 ft.) and six ion-exchange columns 7 ft. in diameter and 24 ft. high.

In addition, there are three 3 ft. by 3 ft. filter presses, two 6 ft. diameter 125-cubic-foot hoppers, two 10 ft. diameter dryers and a drum packer.

In the product packaging area, there appeared to be a small amount of residue fines.

A general schematic of the milling circuits is provided in Figure 3.2.1.

Laboratory Areas – In the laboratory area, the concrete floor and the main structural walls appear to have shifted 9 or 10 inches.

The mill also has a cold storage annex on the south east side. A substantial number of salvaged doors and windows are being stored in this area. Within the building, there are also 15 pallets of magnesium oxide in 25 kg bags and 5 pallets of calcium hydroxide also in bags. Both stacks are well under roof, within the confines of the walls and well protected from weather and the environment. They are stacked in a stable manner. In addition, there is a small amount of scrap steel in this cold storage building.

The generating plant (power house), which was a separate building in front of the mill, has been dismantled, and the generating units and building steel have been transported off-site. However, the area remains littered with all of the siding and other material discarded during the salvage operation. As well, the building's concrete floor, with 3 ft. deep by 2 ft. wide concrete trenches in which piping and wiring was run, remains. As a result, the building has a substantial amount of concrete remaining.

Acid Plant

The acid plant is composed of two separate buildings with piping associated with cooling occupying the area between the two buildings.

Within the acid plant buildings, there is an accumulation of more than 90 barrels that were used to store the spent vanadium pentoxide pellets used as a catalyst in the process. Many of the barrels have corroded over time and the pellets have spilled onto the floor.

The buildings are constructed of steel with asbestos siding. All of the metal work in the acid plant has corroded to a large extent.

There is a substantial volume of elemental sulphur remaining in an uncovered outdoor storage area to the east of the acid plant. The area evidences that, at some time in the past, the pile started on fire.

There are two 40 ft. diameter by 30 ft. high insulated acid storage tanks located behind and slightly to the west of the acid plant on an adjacent elevated rock outcropping. The tanks are empty and most of the conduit piping has rusted away.

Freshwater Pump House

The freshwater pump house is located west of the head frame on a bedrock outcrop. On one side, it is constructed on the bedrock with log supports on other side (the lakeside). The pump house is of cinderblock construction and has concrete flooring. While the

pumps have been removed, there is a quantity of scrap steel, including intake lines that still extend into Lake Athabasca.

In the same area, there is evidence of a propane storage tank building, which, at some point in the past, was entirely dismantled. One propane tank remains and was found to be empty.

North of, and slightly elevated above, the propane tank is a 1,000 gal. (estimated) steel storage tank. The tank is of bolted plate construction and is empty, but appears to have been used for bulk oil storage.

Geology\Mine Dry

The geology/mine dry building is a 150 ft. by 40 ft., two-storey building of structural steel and block construction with fibrous filler used to increase the insulation. The walls are, however, further insulated with what appears to be asbestos that was then painted over. The roof appears to have a spray-on asbestos insulation with no covering. The entire building is sheeted with asbestos siding.

All rooms were checked and no chemicals were found.

There are floor drains and sumps in the concrete ground floor.

There is a large (approx. 300 gal.) asbestos-wrapped hot water heater located in the mine dry area.

Mine Engineering

This building is attached to the maintenance shop with access between the two. It is roughly the same size as the Geology/Mine Dry and is also constructed of structural steel and fibrous blocks, insulation and siding. Partitions for offices were constructed of 2" by 4" lumber and gyproc, in most cases.

All rooms were investigated and no chemicals were found.

The building has concrete floors.

Maintenance Shops

This is a very large building constructed of steel with exterior sheeting of asbestos siding and 14 equipment access doors. The central area of the building houses a large overhead

crane which has been removed and sits on the ground between the building and the flooded pit. There are 15 pallets of Portland Cement in the central area and eleven 10-gallon barrels of what appears to be caustic soda in crystal form. Inside the various bays, the area is littered with a wide array of scrap materials.

There is a 45-gallon drum containing an unidentified liquid in this area. At some point in the past, it appears the barrel had been moved to its present location in an area well-protected from the elements and where, in the unlikely event of spillage, all volumes would be contained within the building.

Cold Storage Building - Dock Area

Approximately 200 ft. by 30 ft. in size, this steel frame building has corrugated tin sheet siding. During the 1970s, a fish processing plant was located in this building. The east end of the building was used for processing while the west end housed the compressors of which a number are still in place. The floor of most of this building is covered with unused cardboard boxes that were originally used to pack fish.

At the west end, there is a storage yard with a large refrigeration plant, which is intact and, in all likelihood, contains freon. It appears this area was also used as an oil storage area as there are a number of used oil drums scattered about and evidence of spillage. This spillage is approximately 25 m in-shore and appears to have happened a number of years ago.

Between this building and the shore of Lake Athabasca, there is a loading area and a large dock which is showing evidence of rot and decay. Although the area is scattered with debris, nothing was identified which would pose a threat to the water quality or aquatic ecosystems of Lake Athabasca.

Bunkhouses (Staffhousing)

These are two-storey, asbestos tile clad housing units approximately 90 ft. by 36 ft. in dimension. One is located immediately west of the mill; the rest are grouped further to the west. These buildings contained a number of single-room apartments with a common bathroom on each floor. There is an asbestos-wrapped hot water heater (approximately 100 gals.) located in each bathroom. The buildings are primarily of 2 x 4 construction with gyproced interior walls. It appears the roofs are constructed of plywood sheeting with 1 ft. X 1 ft. tin tiles for roofing. All hot water pipes are asbestos-wrapped

There were approximately 28 apartments per unit. Entrance and exit ways and exterior stairwells are decayed.

One building appears to be constructed on a concrete basement. The other buildings are constructed on concrete piles that result in 2-foot high crawl spaces under the lower floors.

Cold Storage

Located slightly west and south of the apartment buildings, all that remains of this facility is its original concrete piles and various scrap materials.

Community Centre

This is the largest of the non-production buildings on site. It contained a full-sized auditorium, a four-lane bowling alley, a Hudson's Bay Store, bakery and commissary, numerous walk-in coolers, a bank, post office, billiards room and numerous other club rooms. Built of structural steel and cinder block construction, all ceilings are open and show spray-on asbestos insulation. In many areas, the asbestos is falling from the ceiling and accumulating on the floor.

The building is relatively clear of any type of scrap wood or steel.

In what were the former 'photography club' rooms, there are five, partially-used, 1-gallon bottles of ethyl acetate and ammonia hydroxide.

Within the area of the walk-in coolers, there is a large refrigeration unit, possibly containing freon.

Curling Rink

Most of the curling rink has been dismantled and salvaged. What remains is a 20 ft. section of quonset which was not part of the ice surface. This is of wood construction and nothing was identified of environmental concern.

School

The school is a one-storey building of cinderblock construction with interior walls also of cinder blocks. A central corridor divides the building, with 4 or 5 regular-sized classrooms on either side. The building has a flat roof and its own furnace for steam heat.

Sewage Treatment

This cinderblock building is approximately 30 ft. by 10 ft. in dimension and consists of a pump room in the front and what appears to be a holding tank in the rear. The building is located on the road leading to the 'Married Quarters' housing at the far west end of the site.

Married Quarters

These are two-storey family accommodations built of fibrous blocks forming some of the main structural walls. The buildings are covered with asbestos siding and sit on concrete piles that support the floor. Each contains an asbestos-wrapped hot water heater and piping. There is evidence that the roofs are leaking which has caused a partial collapse of the ceilings in some rooms.

Pump Shed

This a small shed, typical of those used in the utilidor works. A number of these types of sheds exist around the property. It appears some may have been used to house fire fighting equipment. As well, they also contain valve assemblies for the various piping systems in the utilidors.

Concrete Basement

Salvage of this building took place previously and all that remains are the basement walls and a relatively small amount of scrap material.

Group of Cabins West of Marina

A group of four or five cabins are clustered in the trees near the Environment Canada Water Level Station on the shore of the lake, west of the marina, but it does not appear they have been used during the past number of years. They appear to have been constructed of various types of wood salvaged from other facilities on site. While nothing was identified which would be of environmental concern, the area is however littered with debris.

Group of Cabins East of Headframe

This is a group of 19 wood frame cabins constructed as support housing when the fish processing plant was operational. Some have been sheeted with salvaged aluminium siding. All are constructed with materials salvaged from the site.

Barge

An old wooden barge has been beached in the channel blasted between the pit and Lake Athabasca. No longer seaworthy, the abandoned barge is situated well above the water line. The interior appears to have been used, at one time in the past, as a cafeteria, perhaps for the people working at the fish processing plant.

Cookery Concrete Basement

Located south of the staff house near the mill, this structure was burned some time ago and only the basement remains. There is scrap steel within the confines of the basement.

Barrels

There are an estimated 8,000 empty steel barrels in various locations around the site. The majority are 25-gallon drums of which approximately 50% are stored near the acid plant on the waste rock pile or behind the acid plant on the bedrock out crop. There are also a large number in various locations at the toe of the waste rock pile.

The majority of the 45-gallon drums (less than 100) are concentrated in the areas around the fish processing plant and its support buildings (cabins, etc.). Every barrel that was investigated was empty or contained precipitation water as a result of the way in which it was stored. The empty barrels pose a minimal environmental or safety risk.

Fluorescent Light Ballasts/PCB

Many of the lighting fixtures used on the site are fluorescent and, because of their age, potentially contain some concentrations of PCB. While each ballast's concentration of PCB are expected to be low, there may be a sufficient quantity to warrant the development of a special handling strategy for their safe disposal.

3.3.2 Asbestos

As has been indicated in previous discussion of the facilities, asbestos insulation was used extensively in the construction and insulation of a number of the facilities still in existence at the Gunnar mine site. This was confirmed in earlier investigations conducted on site and in follow up laboratory verification of the composition of certain 'insulated' construction blocks encountered on the site.

The majority of the buildings on the site were sheeted in a "slate like" asbestos siding. Hot water pipes were wrapped with asbestos and in a number of the structures there appeared to be asbestos used as the primary insulation. The insulation is, in all cases, in very poor condition and large quantities litter the floor of the various buildings.

Initially, it was thought that the Geology/Mine Dry Building and a number of other structures had been constructed with cinder blocks with asbestos incorporated in the actual block. To positively identify the type of asbestos, samples were collected of both the spray-on insulation material and the cinder blocks used in the construction of the Geology/Mine Dry Building.

Under a polarizing microscope, the spray-on insulating material exhibited birefringence, which confirmed that it contains a very high percentage of crocidolite asbestos. A sample of the bricks used in the Geology/Mine Dry construction was also examined, but were found not to contain asbestos. This sample could not be positively identified but appeared to be a cellulose-loaded Portland cement compound which showed no indication of asbestos content. It is expected the cellulose was added in order to increase the insulating value of the bricks.

The mill, crusher house, acid plant, power house and auxiliary buildings were all sided with a composite board comprised of two sheets of 1/8 inch asbestos board filled with a pressed wood fibre insulation. The roofs of these buildings also contain corrugated asbestos board.

Other mine buildings on the site were constructed using asbestos board. When additional insulation was required, it consisted of a layer of Limpet asbestos fibre that was sprayed on to varying thickness.

In the community centre, the entire underside of the roof was sprayed with 1½ inches of Limpet asbestos and where ceilings were constructed they were composed of ¾ inch Limpet asbestos sprayed on to sheet metal and then painted. All bunkhouses, apartments and staff houses were constructed using asbestos shingles as siding and aluminium roof shingles.

The removal and appropriate disposal of the large volumes of asbestos must be a consideration in any planned activity at the site. The Saskatchewan *Occupational Health*

and Safety Act and *The Occupational Health and Safety Regulations* provide the requirements for the handling of asbestos.

3.3.3 Waste Rock

The total volume of waste rock present on the Gunnar Mining Limited site has been estimated at 2,710,700 m^3 (BBT Consultants, 1986) and includes both mine waste rock and overburden generated from surface stripping of the open pit. The majority of the waste rock is located in two piles immediately to the east of the now-flooded open pit (see Photo Plate 3) and cover a total of approximately 10 hectares (BBT Consultants, 1986). The waste rock is located on the shore of Lake Athabasca with the toe of one of the waste rock piles protruding into the water of the lake proper and into a shallow area immediately east of the waste rock pile itself.

A gamma survey of the entire waste rock pile was conducted in June 1985 by BBT Consultants using a hand held, multiple range Berthold "Ratio/F" gamma dose-rate metre. Readings were taken at heights of 0.1 and 0.2 m above the surface at 73 locations. Survey control for the readings was achieved by a transit and stadia method.

The average readings on the waste rock pile were approximately 150 μR/hr regardless of height. Only ten percent of the readings from the 73 locations were greater than 1 mR/hr. (BBT Consultants, 1986). During a recent (July 2003) inspection of the site, Canadian Nuclear Safety Commission staff reported average gamma measurement on the waste rock pile of 1.49 μSv/h (maximum 6.13 μSv/h) (Stenson to Danielson, 2003).

To attempt to quantify the extent of impact of the waste rock piles on the surrounding air, radon measurements were made, in 1985, at areas of high gamma activity using the "mat" technique by Concord Scientific Corporation (BBT, 1986). One large mat (approximately 3m X 3m) was deployed on the northern edge of the waste rock pile in April 1985 and five cups were placed under the mat to measure radon. Detailed results are reported in BBT, 1986. Generally, the radon levels from the waste rock piles were found to be significantly lower than those on the Main Tailings area and were measured at between 199 and 361 pCi/L with a mean of 250 pCi/L.

During a 1981 investigation of the Gunnar flooded pit, Tones identified two small streams coming from the waste rock piles and estimated the flows at 3-5 L/sec and 1-2 L/sec. ^{210}Lead and uranium concentrations in the water seeping from the waste rock piles were found to be higher than the levels in the flooded pit. Concentrations as high as 26.8 mg/L uranium were present in the waste rock seep water, which flowed directly into Lake Athabasca (Tones, 1982).

The National Uranium Tailings Program Gunnar Field study investigated the identified seeps in 1985 and reported that the seepage flows in June and again in August 1985 were

significantly less than previously reported by Tones. Samples were collected in both June and August 1985. The results of the analysis indicated that the chemistry of the seepage water was not constant, but rather showed both marked local and seasonal variation (BBT, 1986).

BBT (1986) reports that the smaller seepage noted by Tones in 1981 did not exist in 1985 and the more significant seepage stream had a flow of approximately 30% in 1985 when compared to that reported by Tones in 1981, however the general water chemistry of the flows was similar in both studies with wide variations in the uranium and ^{226}Radium concentrations. BBT concluded that the waste rock seepages source shows a very real and marked seasonal and yearly variation that depended on yearly and seasonal precipitation patterns.

Although the ^{226}Radium and uranium concentrations in the 1985 waste rock seep were measured at approximately 1 Bq/L and 2.0 mg/L, the fact that seepage flows of between 1 and 5 L/sec were low in comparison to the dilution in the receiving environment of Lake Athabasca suggest that any ecological effects would be very localized if they exist at all (BBT, 1986).

3.3.4 Tailings

Mill tailings were originally discharged from the mill at 32% solids through a 1,500 ft. long, 10 in. diameter wooden stave pipe. In total, it has been estimated that the Gunnar Mining Limited mill discharged a total of 4.4 million tonnes of tailings during operations (BBT, 1986).

The tailings and other aqueous wastes were initially discharged into a small lake located 500 m to the north of the mill (Ruggles et al., 1978) that is referred to in historical documentation as either Blair Lake or Mudford Lake. This area is currently referred to as the Gunnar Main Tailings. In 1958, the mill installed a cyclone plant with four sand storage tanks for the production of sand backfill in the underground mine.

The Gunnar Main Tailings basin eventually filled with tailings solids and a small rock outcrop was blasted to allow the tailings to flow from the Main area to a small depression referred to as Gunnar Central Tailings. Once this relatively small basin was filled, the tailings continued to flow downhill, eventually entering Langley Bay, Lake Athabasca. During operations, a sufficient volume of tailings was discharged and allowed to flow into Langley Bay so as to eventually cut Langley Bay into two separate portions: one which is still connected by a narrow channel to Lake Athabasca proper and a smaller 'back bay' which has intermittent connection to Langley Bay itself.

Historical investigations of the three Gunnar tailings areas during 1984 and 1985 indicate that the depth of tailings in Gunnar Main is approximately 14 m, in Gunnar Central 3-4 m

and in Langley Bay, 2-4 m. In each case, the tailings are underlain by a peat or organic clay layer which is 0.5-9.4 m in thickness under Gunnar Main, 3-6 m under Gunnar Central and 8-16 m under the Langley Bay tailings (BBT Consultants, 1986). This layer of clay, which had an *in situ* permeability of approximately 10^{-7} cm/s, forms a reasonably tight physical and geochemical seal under all the tailings and as a result, all of the water transported from the tailings occurs as either very shallow groundwater flow or as surface flows.

3.3.5 Flooded Pit

The open pit mine at Gunnar was depleted in 1961 and ore from underground was used solely to supply the mill until October 1963. The mine was officially closed early in 1964.

Shortly thereafter, the blasting of a narrow, relatively shallow trench between the pit and the lake itself breached the narrow bedrock ridge that separated the open pit from Lake Athabasca. As a result, water from Lake Athabasca was allowed to flow directly into the open pit, eventually flooding the underground workings as well as the pit itself. The channel between the lake allowed the free movement of water (and presumably aquatic organisms) between the lake and the flooded pit until 1966 when the channel was blocked by filling it with waste rock.

In 1971, the Athabasca Native Fisherman's Co-operative established and began the operation of a fish processing facility at the former Gunnar Mining Limited primarily using the warehouse building near the main dock (Figure 3.3.1). In 1975, the facility was taken over by the Freshwater Fish Marketing Corporation, which continued to operate the plant until the end of 1980. During the following year, fish were dressed at the Gunnar site but were then flown to out to other plants for processing. During the entire time the processing plant was in operation, including 1981, wash water used in the fish processing plant and offal from the processing and dressing operations were disposed of in the flooded pit (Tones, 1982).

The flooded pit at the Gunnar site is approximately 300 m long and 250 m wide with a total estimated surface area of approximately 7 hectares. The flooded pit has a maximum depth of 110 m and a shoreline perimeter of 1700 m (Tones, 1982).

Table 3.3.1 provides a summary of the analyses of surface water samples collected from the flooded Gunnar pit since 1978.

In the most recent sampling of the surface water in the flooded pit (2002), all analyte concentrations were measured below Saskatchewan Surface Water Quality Objectives for the protection of aquatic life. However, ^{226}Radium and uranium concentrations were elevated with ranges of 0.22-0.25 Bq/L and 859-865 μg/L, respectively (CanNorth,

2002). It is noted that the "*general surface water quality objective*" for ^{226}Radium in Saskatchewan is 0.11 bq/L.

3.3.6 Ambient Radon

Figure 3.3.2 provides the location of 13 monitoring stations established by Concord Scientific Corporation in 1985. At each station a Terradex TRACK-ETCH Type 'F' detector was deployed in a protective canister 1 metre above the ground. Two of the sites contained duplicate detectors to allow a measure of sampling precision to be obtained.

Table 3.3.2 provides a summary of the data collected during this monitoring campaign.

3.4 *Recent Activities*

3.4.1 Securing Site Buildings

In August/September 2003, the Government of Saskatchewan completed a number of activities at the Gunnar Mining Limited site designed to limit casual access to the mill building, the bulk ore storage building near the mill, the acid plant, head frame, community centre and bulk storage tanks. These activities included:

Mill Building, Head Frame & Acid Plant

- If entry to the building could not be adequately secured, all internal stairways were removed at a height of not less than 2.5 metres above the floor.
- All exterior stairways and ladders reaching to ground level were cut off at a height of not less than 2.5 metres from the ground.
- Chain link fencing was securely installed so as to limit all access to the capped mineshaft.
- All doors, if they existed, were closed and secured by permanently welding, welding a steel reinforcement to permanently close or anchored by fastening with bolts/screws (with bolts/screws left in an inoperable manner).
- If no door existed, then the opening was secured with 8' chain link fencing welded or anchored to the building using screws/washers (with screws left in an inoperable manner).
- All window openings extending to less than 2.5 metres above the ground were secured using chain link fencing welded or anchored to the building using screws/washers (with screws left in an inoperable manner).
- All other openings (due to vandalism, deteriorated siding, etc.) less than 2.5 metres from the ground that would allow access into the buildings were secured with chain link fencing welded or anchored to the building using screws/washers (with screws left in an inoperable manner).

Bulk Ore Storage Tank Near Mill

- Chain link fencing, securely fastened, was used to close off an approximate 30' length of sidewall missing from the lower reach of the western-most conveyor that leads to the mill from the south ore bin tower.

Community Centre

- All doors, if they existed, were closed and secured by permanently welding them, or by welding steel reinforcement to permanently close the door, or by anchoring them using screws/bolts (with screws/bolts left in an inoperable manner)
- If no door existed, then the opening was secured with 8' chain link fencing welded or anchored to the building using screws/washers (with screws left in an inoperable manner).

Bulk Storage Tanks

- Any exterior access ladders on the water tower and acid storage tanks located west of the Acid Plant Building and on the bulk fuel storage tank located near the shore to the west of the maintenance building were cut off at a height of not less than 2.5 metres above the ground.

A local contractor completed the identified work between August 21 and August 31, 2003. Following completion of the work, representatives of Saskatchewan Environment and Saskatchewan Northern Affairs conducted a site inspection on September 1, 2003 and the contractor addressed all deficiencies identified during the inspection by September 2, 2003.

3.4.2 Posting of Warning Signs

A total of 50 (fifty) 4 ft. x 8 ft. coroplast signs were installed at various locations throughout the Gunnar Mining Ltd. site to warn casual visitors to the site of the danger posed by radiation, asbestos and the unsafe structural condition of the buildings. Figure 3.5.1 shows a mock-up of the sign design, while Photo Plates 5-9 show the placement of 6 of the 50 actual *in situ* signs posted at the site during August 2003. The signs warn in both English and Dene of the potential risk posed by radiation, asbestos and the structural integrity of the buildings, and instruct the public not to enter.

The signs were anchored every 18-24 inches to the buildings and the anchoring hardware within ground reach was left inoperable. These measures were undertaken to deter vandalism or the removal of the signs. Plastic signs are anticipated to be more effective and longer lasting because, unlike plywood, they have no secondary use by local people in the area. Therefore, there is less risk of people removing the signs for their construction value.

Free-standing signs to be erected near the tailings area and at other specified locations throughout the site were glued to plywood backing boards and then mounted, with their bottom edges a minimum 5 feet from the ground, on welded steel 6-legged stands. The elevation of the signs ensures they are readily visible, even in winter. The weight of the free-standing welded stands is intended to discourage vandalism of the signs.

The warning signs were posted as follows:

Mill Building - (14 signs):

- 2 signs secured to the east end of the building;
- 6 signs secured to the front (southern face) of the building;
- 4 signs secured to the two ore bin towers (2 each) at the west end of the mill building; and,
- 2 signs secured to the north (back) side of the building.

Acid Plant Building - (6 signs):

- 4 signs secured to the front (south side) of the building (2 on each half); and,
- 1 sign secured to each of the east and west ends of the building.

Head Frame Main Building - (4 signs):

- 1 sign on each side of the main building

Other Buildings on Site - (14 signs on 13 buildings):

- 1 sign secured to the south face of the old fish plant building at its east end;
- 1 sign secured to the north side of the mine dry/geology building (located immediately north of the headframe);
- 1 sign secured to the front (east end) of the engineering building (adjoins the maintenance building along its southern edge);
- 1sign secured to the front (east end) of the centre bay of the maintenance building, above the two industrial door openings;
- 1 sign secured to the former lodge building located amongst the trees to the southeast of the engineering building towards the lake;
- 1 sign secured to the front (south side) or otherwise most prominent face of each of the four (4) residences located immediately to the west of the mill building;
- 1 sign secured to the front face (along the road) of each of the other two residences located to the west of the former rec centre/sports complex;
- 2 signs secured to the former store/rec centre/sports complex – one on the north side and one on the south side; and,
- 1 sign to be secured to the north side of the former school (showing to the road side).

Tailings Area (2 Signs)

- 1 sign was erected near the edge of the tailings area at the end of the trail leading up from the west residence; and
- 1 sign was erected near the edge of the tailings area at the end of the trail leading up from the acid plant building.

Additional Locations Throughout the Site (7 signs):

- 1 sign was erected along the road leading to the store/rec centre/sports complex, at the western edge of the clearing (old soccer pitch) in front of the main residences;
- 1 sign was erected along the road leading from the store/rec centre/sports complex & west residences, at the eastern edge of the clearing (old soccer pitch) in front of the main residences;
- 1 sign was erected near the shore at the docks in front of the old fish plant;
- 1 sign was erected near the shore in the centre of the clearing (old soccer pitch) in front of the main residences;
- 1 sign was erected on the road leading to the site from the airstrip;
- 1 sign was erected near the water tower on the trail leading up to the tails, behind the acid plant building; and,
- 1 sign was erected at the fork in the road, near the loose sulphur deposit at the east end of the acid plant building.

In addition, the local contractor completing the work was given leave to exercise discretion, as he saw the need, in placing 3 spare signs that had been ordered as replacements for any signs that might be damaged during their placement. These additional signs were placed on the former rec centre building, the former fish packing plant (warehouse) near the docks and on the geology/mine dry building.

3.4.3 Communications with Local Public

During the summer of 2001 and 2002, as part of Saskatchewan Environment's multi-year Abandoned Mines Assessment Program, an assessment was completed on all abandoned mines (uranium, gold and base metal) in the Uranium City area. The assessment consisted of inspecting each abandoned mine site in order to identify and to rank public safety risks and potential impacts that the sites may be having on the surrounding environment.

The inspection included all aspects of the mine itself and of the surrounding area. This included such things as locating and examining the current condition of any adits, shafts or raises, inspecting any debris and/or old buildings that may still exist, and photo documenting the site. Other activities included collecting water samples (when discharges were evident) and conducting a survey of gamma radiation levels at any of the sites where uranium was mined in the past.

During both years that the assessment took place, members of the community of Uranium City were often consulted in regard to locations and access to the sites under investigation. In addition, during both years, a local Uranium City resident was hired as part of the assessment team. As Uranium City is a small community (less than 200 people at the time), this served to significantly increase the local awareness and discussion of risks and related issues posed by the sites.

The public release of the Abandoned Mines Assessment Program reports by Saskatchewan Environment also served to raise the level of local understanding of the potential safety, radiological and environmental risks posed by some of the sites.

In addition, representatives of the Government of Saskatchewan have attended a number of fora in 2002 and 2003 in order to inform people, particularly residents of the area, of the risks posed by abandoned uranium mines in the north.

Of particular note in this regard is Saskatchewan Environment's and the Medical Health Officer's (northern Regional Health Authorities) attendance at a public meeting held in Uranium City on April 22, 2003. The public meeting was sponsored by Cameco Corporation to discuss the results of an environmental and human health assessment conducted on the residual impacts associated with the decommissioned Beaverlodge uranium mine and mill facility. A portion of the agenda was given over to Saskatchewan Environment and the Medical Health Officer to discuss not only the risks associated with that site, but also those associated with the other uranium sites located in the region.

In addition, Saskatchewan Environment and the Medical Health Officer posted public notices in every Athabasca Basin Community advising residents of the area not to drink untreated water from any lake or river and not to consume raw water from a number of specific lakes, including Beaverlodge, Nero and Langley Bay on Lake Athabasca as they contained elements that would not be eliminated by boiling. The public notice also recommended appropriate consumption levels of fish from Beaverlodge Lake, Langley Bay and a number of other lakes in the area.

Representatives of the Northern Saskatchewan Environmental Quality Committee are also present during regularly held inspections of the decommissioned Beaverlodge facilities near Uranium City and often raise the issue of the 'other' former uranium mining and milling sites in the region. Representatives of Saskatchewan Environment are always in attendance at these meetings and use the opportunity to inform the participants of the risks associated with the various sites and to recommend that community members avoid the sites if at all possible.

3.4.4 Instruction to Local Outfitters

On February 1, 2003, Saskatchewan Environment informed all outfitters in the Athabasca region as to the risks posed by all types of abandoned mines in the Uranium City area.

A letter was sent to each outfitter in the region pointing out that there are a number of abandoned mines that may present a risk to people who visit the sites and that plans are being prepared to address the sites of highest risk to both people and the environment. However, until such work is complete, Saskatchewan Environment formally requested that the outfitters and their staff keep clients and other visitors away from all abandoned mine sites.

The letter also stated that as part of the Abandoned Mines Assessment Program conducted from 2000 to 2002, an assessment was made of the 42 abandoned uranium mines located in the Athabasca Region and identified the Gulch, Gunnar and Lorado mine sites as the most accessible. Hazards identified at the Gulch mine, which is located on Black Bay, Lake Athabasca, include an open adit and dilapidated buildings. At the Gunnar site on the Crackingstone Peninsula, hazards include deteriorating buildings, radioactive tailings and an unstable steep-walled pit. The Lorado site was identified as having hazards that include radioactive, acid-generating tailings and an acidic lake. The letter went on to draw the outfitters' attention to the fact that the Gunnar and Lorado sites have signs posted warning people not to enter these locations.

Saskatchewan Environment concluded by requesting that each outfitter advise their clients to stay away from all abandoned mines and that they report any activity observed at an abandoned mine site to the department by phoning their La Ronge or Stony Rapids offices, and provided the appropriate phone number for each.

3.4.5 *Site Inspections*

Environmental site inspections have been conducted regularly at the Gunnar and Lorado sites, in 1993 and 1996, and annually from 1998-2003. These inspections typically include physical inspections and gamma surveys of the buildings, facilities and grounds, as well as the collection of water samples from locations on and around the sites to identify any changes that might have occurred. As previously indicated, the Gunnar and Lorado sites were also subject to specific environmental site assessments in 2000, as part of Saskatchewan Environment's broader assessment of abandoned mines in northern Saskatchewan.

Throughout the 2003 open water season, a number of additional inspections of the Gunnar Mining Limited site were carried out. The date of each inspection is listed below as well as an identification of the agency involved in the inspection.

- *July 5, 2003* - Representatives of Saskatchewan Environment, Shield EcoRegion
- *Aug. 23, 2003* - Representative of Saskatchewan Environment, Shield EcoRegion
- *Aug. 27, 2003* - Representative of Saskatchewan Labour
- *Sept. 1, 2003* - Representatives of Saskatchewan Environment and Saskatchewan Northern Affairs

The August 27, 2003 inspection by representatives of Saskatchewan Labour was scheduled during the time that a local contractor was engaged on the site completing certain site safetying work, as earlier described. This inspection was timed to review the contractor's general compliance with occupational health and safety requirements, as well as to ensure appropriate asbestos abatement and handling methods were being employed by the contractor and his employees in completing work on site.

Representatives of the Canadian Nuclear Safety Commission also conducted a site visit/inspection during the first week of July 2003.

3.4.6 Site Water Quality Investigations

Water quality analysis of samples collected on and around the Gunnar Mining Ltd. site has been completed by a number of individuals for a number of different reasons since 1978. Of more relevance in this discussion are those monitoring programs that have been completed within the past ten years.

For example, Saskatchewan Environment has collected water samples from the centre of Langley Bay in 1993, 1996, 1999 and 2002 and submitted the samples to the Saskatchewan Research Council (SRC) for analysis. In addition, a sample was collected from the water discharging from the 'back bay' in 2001. During operations, tailings were allowed to overflow the Gunnar Central tailings area and into Langley Bay where they formed a beach that cut the bay in half. That tailings beach is still in place today.

The result of these various water quality investigations is summarized in Table 3.4.1. Table 3.4.2 provides a summary of various applicable guideline values for comparison.

A review of Table 3.4.1 shows that in the most recent sampling conducted in Langley Bay, in spite of the presence of tailings within the bay, the concentration of all parameters remain below Saskatchewan Surface Water Quality Objectives (SSWQO) for the Protection of Aquatic Life and relevant CCME water quality guideline values. In addition, the uranium concentrations within the bay are below both the federal and provincial recommended drinking water quality value.

In the 'back bay' portion of Langley Bay, iron concentrations (1.1 mg/L) are slightly above the SSWQO of 1.0 mg/L and the CCME Guideline value of 0.3 mg/L. In addition, uranium concentrations at 26 μg/L exceed the recommended drinking water value of 20

μg/L and ^{226}Radium concentrations (0.97 Bq/L) exceed the recommended SSWQO value of 0.11 Bq/L.

Table 3.4.3 presents the results of a 1993 monitoring program that collected water samples from Lake Athabasca at locations 1 m off shore at three strategic locations that have the potential to be impacted by the Gunnar Mining Ltd. site: (1) opposite the waste rock pile; (2) opposite the flooded pit; and (3) 1 m from the mouth of Langley Bay. The 'Bushell Bay' location was included as a control station and is located approximately 15 kilometres from the site.

A review of Table 3.4.3 shows that at all three locations, the Gunnar Mining Limited site is having no measurable impact on the water quality of Lake Athabasca.

3.4.7 Gunnar Pit Investigation

In August and September 2002, representatives from Saskatchewan Environment and Canada North Environmental Services completed two field surveys of the flooded pit at the Gunnar Mining Limited site.

Canada North Environmental Services were retained by COGEMA Resources Inc. to conduct a reconnaissance survey of the flooded Gunnar pit to repeat specific monitoring components of an earlier investigation of the flooded pit conducted by the Saskatchewan Research Council (SRC) in 1981 (Tones, 1982).

The primary objective of the 2002 study was to collect limnological, water chemistry, sediment chemistry, plankton, benthic invertebrate and fish community data in order to obtain recent information on the state of the aquatic environment in the flooded pit. A habitat assessment of the pit was also completed and, as appropriate, the data was compared to the 1981 SRC study in order to assess the ecological status of the flooded pit 21 years after the initial assessment.

The results of water quality analysis conducted in 2002 as part of this program have been included in Table 3.3.1 to allow for comparison with the previous water quality analyses conducted on flooded pit water from the Gunnar site.

In 2002, water samples were also collected from a seep at the base of the waste rock pile (Seep-1) and at a seep located between the pit and Lake Athabasca (Seep-2). In addition, a water sample was also collected in Lake Athabasca at the edge of the waste rock pile in a wet lowland area (Seep-3). Seep 1 was the only location in which water samples were analysed in the 1981 investigation by the SRC.

During the 2002 study, several analytes were found at lower concentrations in the Seep-1 water than those reported in the 1981 SRC study, particularly ^{210}Lead (0.19 Bq/L in 2002

versus 2.0 Bq/L in 1981) and uranium (8.9 mg/L in 2002 versus 18.0 mg/L in 1981). However, a few analytes including selenium, organic carbon and ^{226}Radium were measured at higher concentration in 2002 than reported in 1981 (selenium 0.01 mg/L in 2002 versus 0.002 mg/L in 1981; organic carbon 16 mg/L in 2002 versus 5 mg/L in 1981; ^{226}Radium – 0.85 Bq/L in 2002 versus 0.16 Bq/L in 1981). In addition, the levels of copper and lead in the sample from 1981 exceeded Saskatchewan Surface Water Quality Objectives, while the levels of copper and selenium in the sample from 2002 were equal to guideline values.

The water quality of Seep-2 mirrored that of the pit's surface water quality for most parameters, suggesting that this seep is largely composed of pit water and all concentrations were below the SSWQO. The water from Seep-3 had a few analytes present in higher concentrations than in 1981 including iron, manganese, nitrite + nitrate nitrogen, organic carbon and soluble silicon. Conversely, the levels of ^{226}Radium, uranium and all inorganic ions, as well as other measures of ion levels, were substantially lower. All concentrations were below SSWQO.

This most recent monitoring campaign of seepages from the waste rock piles at the Gunnar site further validates the 1986 conclusion by BBT that any ecological effects of the seepage on Lake Athabasca would be very localized if they existed at all (BBT, 1986).

The analyte levels measured in deep and shallow sediment samples from the flooded pit were compared to the Interim Sediment Quality Guidelines (ISQG) and the Probable Effects Level (PEL) recommended by the Canadian Council of Ministers of the Environment for arsenic, cadmium, chromium, copper, lead and zinc. The mean concentrations of metals measured in the sediment samples from the deep site in the flooded pit all exceeded the ISQG, but not PEL, with the exception of cadmium. In the sediments samples collected from the shallow site, the mean concentration of metals were all lower than the ISQG.

In two phytoplankton samples collected from the flooded pit, there was a total of 33 taxa identified and a mean abundance of 3,958,100 ± 36,030 cells/L and the Shannon-Wiener diversity index was relatively high at 3.03 ± 0.03. The Simpson's dominance index for the phytoplankton samples from the pit was low measuring 0.17 ± 0.02. The results of these indices suggest a stable and numerically even phytoplankton community (CanNorth, 2002).

The same two indices that were used to assess the phytoplankton community were used to assess the zooplankton community and resulted in a Shannon-Wiener diversity index of 2.62 ± 0.12 and a Simpson's dominance index value of 0.23 ± 0.02. Although these values are slightly lower than the indices calculated for the phytoplankton samples, they are still favourable and reflect a diverse and numerically even zooplankton community.

In general, the samples collected from the shallow sediments in the flooded pit contained a diverse and abundant benthic invertebrate community that was dominated by contaminant tolerant taxa, but also consisted of species that are considered contaminant sensitive taxa such as *Emphemerota* (mayflies) and *Tricoptera* (caddisfly)(CanNorth, 2002).

A total of 29 northern pike (*Esox lucius*) were capture from the flooded pit by standardized test netting. Additionally, one juvenile northern pike was capture by electro-fishing and two northern pike were observed. Although no small-bodied fish were caught in the minnow traps, there was one ninespine stickleback (*Pungitius pungitius*) captured by electro fishing and two ninespine sticklebacks were identified in the stomach of one northern pike.

The northern pike population residing in the flooded pit appeared healthy externally and internally, based on brief field examinations. The sub-sample that was sexed indicated a even sex ratio since eleven males and ten females were caught. A wide range of northern pike size classes were captured and the abundance was relatively high. The northern pike population in the flooded Gunnar pit appears to be self-sustaining since there was evidence that they were reproducing in the pit (juvenile fish were located) and migration from other water bodies is not possible (CanNorth, 2002).

In the 2002 investigation, the aquatic community within the flooded Gunnar pit did not show signs of deterioration when compared to the results of the SRC investigation 21 years previously. On the contrary, in 2002, the flooded Gunnar pit was found to contain a good diversity of aquatic biota in a number of groups (phytoplankton, zooplankton, benthic invertebrates, and macrophytes), as well as a self-sustaining population of northern pike (CanNorth, 2002).

3.4.8 Migratory Water Fowl Investigation

The results of a 2001 sampling of migratory waterfowl resident at an operating uranium mine site in northwest Saskatchewan showed elevated levels of some radionuclides in various tissue samples. As a result, Saskatchewan Environment decided to attempt to harvest migratory waterfowl from former uranium facilities in the Uranium City area. In the fall of 2002, two migratory waterfowl were harvested from the Gunnar Mining Limited site. A Horned Grebe resident on a small pond of water on the Gunnar Main tailings area and a Red Breasted Merganser from Langley Bay were both harvested. Muscle, kidney and liver tissues were submitted to the Saskatchewan Research Council for analysis.

Table 3.4.4 presents the results of the radionuclide analysis of the harvested birds. For comparison, the results from a similar program conducted at both the COGEMA

Resources Inc. Cluff Lake mine site and the Cameco Corporation Rabbit Lake mine site are provided.

Given the similarity of the concentrations of radionuclides in the waterfowl sampled at the Gunnar site compared to concentrations found in waterfowl taken from current operating sites, it can be assumed that such waterfowl from the Gunnar site pose minimal risk to humans, if consumed.

3.5 *Current Conditions*

3.5.1 Water Quality

Recent monitoring data (2002) from Langley Bay (Table 3.4.1) indicates that the concentrations of all parameters are below the Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life and relevant Canadian Council of Ministers of the Environment (CCME) water quality guideline values. In addition, the uranium concentrations within the bay are below both the federal and provincial recommended drinking water quality value in spite of the presence of tailings within the bay.

Monitoring data (1993) from 1 m off shore indicates the Gunnar Mining Limited site having no measurable impact on the water quality of Lake Athabasca (Table 3.4.3).

In 2002, the flooded Gunnar pit, which is isolated from Lake Athabasca, was found to contain a good diversity of aquatic biota in a number of groups (phytoplankton, zooplankton, benthic invertebrates, and macrophytes), as well as a self-sustaining population of northern pike (CanNorth, 2002).

3.5.2 Radiation

Representatives of Saskatchewan Environment and Public Safety made a series of gamma measurements in June 1993 and representatives of the Canadian Nuclear Safety Commission made a similar series of measurements in July 2003 (Stenson to Danielson, 2003). Tables 3.5.1 and 3.5.2 present the results of those measurements.

The primary issue to be addressed by the Saskatchewan Environment survey was the identification of any areas of elevated radiation which would be of concern in terms of the health and safety of workers who, theoretically, would spend an extended period of time on the site during a decommissioning and reclamation operation.

Generally, the site does not exhibit gamma radiation levels that would constitute a serious concern for workers involved in a clean up. None of the areas of the site present gamma measurements at a level that would warrant special precautions to guard against gamma

radiation over a short time period. However, persons visiting the site should avoid excessive inhalation of contaminated dust and should observe general industrial hygiene practices; hands should be washed before eating and coveralls should be worn to protect under-clothing from picking up contaminants.

Radiation levels in the support buildings range from a background of less than 0.1 μSv/h to 1.5 μSv/h (at 1 metre), the latter of which is a measure of the levels on the haul road from the head frame to the mill.

As was expected, the highest gamma radiation levels were found in the mill building and two piles of fines near the mill annex. The string filters in the mill had gamma levels ranging from 5.0 to 12.0 μSv/h (at surface) – the highest levels measured anywhere on the Gunnar site. In the product packaging area of the mill, gamma radiation levels of 10 μS/h were measured in the vicinity of what appeared to be residual U_3O_8 remaining from operations. The total volume of residual product was less than 0.25 m^3.

On the exterior of a conveyor annex slightly south of the mill itself three piles of fines (approximate total volume of 3 m^3) were identified which had elevated gamma radiation levels. These were measured at 5.0 μSv/h at 1 m (6.0 - 7.0 μSv/h at surface).

The remains of the tailings pipeline from the rear of the mill to the tailings area shows evidence of spillage along its entire length. However, gamma levels were generally less than 2 μSv/h. There is a great deal of revegetation occurring through the spillage material, including trees in excess of 2 m in height.

A number of gamma measurements have also been taken of the Gunnar tailings areas and are presented in Table 3.5.1. The tailings themselves typically had a gamma level of 3 μSv/h at 1 m and exhibited the approximation of an infinite-plane source in that the dose rate varied very little with the height at which the measurement was taken.

A post-decommissioning gamma radiation level of 250 μR/h (≈2.5 μS/h), as the maximum dose from any individual area, provides a reasonable basis for evaluating gamma radiation surveys in support of decommissioning. These levels have been applied recently in the development of decommissioning plans for the Cluff Lake uranium mine. At the time that the Eldorado Beaverlodge mill and mines were decommissioned, an objective of 250 μR/hr was also applied for waste rock piles (Eldorado, 1983). In addition, however, it is important that the public dose limit of 1 mSv/a (1,000 μSv/a) above the dose from natural background, not be exceeded under reasonable, casual access scenarios.

The gamma survey conducted by Saskatchewan Environment and reported in Tables 3.5.1 and 3.5.2 was carried out using the Automess AD 6 survey meter. This instrument reports in μSv/h units but, in fact, actually measures μR/h and assumes a simple conversion to μSv using a factor of 0.01. In reality, the conversion factor is smaller.

While various conversions can be developed, the UNSCEAR 1993 report assumes a default conversion factor of 0.7 Sv/Gy for converting absorbed dose in air to effective dose received by adults. Thus, the simple conversion implicit in the Saskatchewan Environment survey results is a conservative overestimate of the dose to a casual visitor to the Gunnar Mining Limited property. This overestimate is used in the subsequent dose calculations.

For many other sites in Ontario and Saskatchewan, a dose from casual access has been estimated for a person who is assumed to spend 200 h/a on site. In the present context, it would seem reasonable to assume that an individual, who might access the Gunnar Mining Limited site for the purpose of hiking, snowmobiling or hunting, would spend an aggregate total of no more than 200 h/a on the property given the relative remoteness.

The following table provides a summary of the length of time an individual would have to spend at different locations on the Gunnar Mining Limited property in order to receive a dose equal to the limit of 1 mSv/a prescribed for members of the public in the *General Nuclear Safety and Control Regulations* issued pursuant to the Canadian *Nuclear Safety and Control Act*.

Maximum Time a Person Would Have to Spend on Individual Properties to Exceed Public Dose Limit

(*Note: "Average Gamma" values are a conservative overestimate of dose, as per above discussion*)

Areas of the Site	*Average Gamma (μSv/h) Using Automess AD6*	*Residence Time Required to Acquire Prescribed Dose Limit to the Public (1 mSv/a)*
Haul Road (Head frame to Mill)	*1.5*	*667h (27.7 days)*
Yard in Front of Mill	*2.0*	*500h (20.8 days)*
Fines Piles (ore Conveyor)	*5.0*	*200h (8 days)*
Gunnar Main Tailings	*3.0*	*333h (13.9 days)*
Gunnar Central Tailings	*2.29*	*436h (18 days)*
Langley Bay Tailings	*4.67*	*214h (8.9 days)*
Gunnar Waste Rock	*1.49*	*671h (27.9 days)*

Generally, the site does not exhibit gamma radiation levels that would constitute a serious concern for casual site visits, as none of the areas of the site present gamma readings at a level that would warrant special precautions to guard against gamma radiation over a short time period. However, persons visiting the site should avoid excessive inhalation of contaminated dust and should observe general industrial hygiene practices; hands should be washed before eating and coveralls should be worn to protect under-clothing from picking up contaminants.

The following table provides a summary of potential future land uses of the Gunnar Mining Limited property, and suggests actions that could be undertaken to prevent, reduce or eliminate any risks associated with such potential usages.

Potential Land Use of the Gunnar Mining Ltd. Property

Potential Use of Property	*Suitability Related to Property Use*	*Potential for Future Property Use*	*Issue Addressed By*
Permanent Residence	*- No services* *- Difficult to access* *- Inhospitable landscape(waste rock)* *- Many more suitable alternative locations*	*- Highly Unlikely*	*- Post warning signs* *- Institutional control registration of property to prevent such uses*
Temporary Residence (Cabin – Recreation or Traditional Pursuits)	*- Difficult to access* *- Inhospitable landscape (waste rock – no protection from elements)* *- Many more suitable alternative locations*	*- Minimal*	*- Post warning signs* *- Institutional control registration of property to prevent establishment of facilities to support recreation*
Tenting /Camping	*- Inhospitable landscape (waste rock – no protection from elements)* *- Many more suitable alternative locations*	*- Possible*	*- Decommission buildings* *- Post warning signs* *- Institutional control registration of property to prevent establishment of facilities to support recreation*
Traditional Pursuits (Trapping, Hunting, Fishing)	*- Little suitable habitat for fur bearers, food animals or fish* *- People may traverse the area to access other, more suitable areas*	*- Minimal*	*- Post warning signs* *- Institutional control registration of property to prevent establishment of seasonal residence*
Seasonal Outfitters Use	*- Existing gravel airstrip* *- People may traverse the site to access L. Athabasca*	*- Probable*	*- Post warning signs* *- Institutional control registration of property to prevent establishment of seasonal residence*
Mineral Exploration	*- Very small area mined* *- Properties are located in mineralized region, and therefore there is potential for future exploration*	*- Low* *- Uranium grade is <0.20 % U_3O_8 therefore uneconomical for further development at current prices* *- Other minerals may be present, however none are indicated at this time*	*- Institutional control registration of property* *- Persons carrying out uranium exploration are likely to have appropriate technical knowledge*

Based on a review of the two preceding tables, it is evident that the Gunnar site poses a minimal risk to members of the public to exceed the incremental dose of 1 mSv/a under current scenarios where access to the area remains generally remote but unrestricted. Interest in, and the frequency of, casual visits to the site would diminish significantly if existing infrastructure on site (e.g., the head frame, acid plant, mill and support buildings, etc.) were removed, as there would be no features of interest to draw members of the public to the site. The dismantling of the existing buildings would likely reduce the number of and total length of any casual visits by members of the public to the site.

3.5.3 Conventional Public Safety

The facilities at the Gunnar Mining Limited site were constructed during the late 1950s and were abandoned by the company in 1964. No maintenance has taken place on any of the facilities since the operation ceased and, therefore, the natural processes of time have made a number of the existing buildings unsafe. Since 1964, salvage of some equipment such as the leach tanks, all components of the crushing circuit, the entire powerhouse and its contents, as well as various wooden buildings and building parts has also taken place.

Generally, the site is in a shape that would be expected of a mine that has been abandoned for approximately 40 years. Scavenging and some vandalism is evident in a number of buildings and this has had varying levels of effect on the structural integrity of some buildings.

Asbestos insulation was used extensively in the construction and insulation of the majority of the facilities at the Gunnar mine site. This was confirmed in earlier investigations conducted on the site and in follow up laboratory verification.

In August –September 2003, the Government of Saskatchewan completed a number of activities at the Gunnar site designed to stop access to the mill building, the bulk ore storage building near the mill, the acid plant, head frame, community centre and bulk storage tanks.

During the same time, a total of 50 (fifty) 4 ft. x 8 ft. coroplast signs were installed at various locations throughout the Gunnar site to warn casual visitors to the site of the danger posed by radiation, asbestos and the unsafe structural condition of the buildings. Signs were placed on the head frame (4), the mill (14), acid plant (6), tailings area access routes (2), as well as in seven other areas of access to the site itself and on other, non-production facilities located on the site.

3.5.4 Preliminary Identification of Risk

The following table provides an initial assessment of the various environmental, radiological and public safety risks posed by the Gunnar Mining Limited site, as it currently exists. The table also provides a preliminary discussion of potential mitigative actions that could be used to address the identified risks. The reviewer will note that, with regards to the Gunnar Main, Central and Langley Bay tailings areas, the table is recommending a cost/benefit analysis be conducted of possible mitigative options.

Risks posed to the public by the various aspects of the site would diminish significantly if existing infrastructure (e.g., the head frame, acid plant, mill, and support buildings, etc.) were removed, as there would be little of interest to draw members of the public to the site. The dismantling of the existing buildings would likely reduce the number and total length of any casual visits by members of the public to the site, and therefore the risk.

Preliminary Identification of Risk, Source of Risk & Potential Mitigation

Site Areas	Environmental Risk	Radiological Risk	Public Safety Risk	Source of Risk	Potential Mitigation
Head Frame	Negligible risk	Negligible risk	Moderate risk	Structural Asbestos	Dismantle Asbestos protocols
Mine Shaft Closure	No risk	No risk	Moderate risk	Cap integrity unknown	Install appropriate cap
Raise Closure (Assumes exists)	No risk	No risk	Moderate risk	Cap integrity unknown	Install appropriate cap
Acid Plant	Minor risk	Negligible risk	Major risk	Spent chemicals Structural Asbestos	Appropriate disposal Dismantle Asbestos protocols
Mill	Minor risk	Moderate risk	Major risk	Spent chemicals Radiation (specific areas) Structural Asbestos	Appropriate disposal Appropriate clean-up/disposal Dismantle Asbestos protocols
Mine Support Buildings	Negligible risk	Negligible risk	Negligible risk	Structural Asbestos	Dismantle Asbestos protocols
Other Ancillary Buildings	Negligible risk	Negligible risk	Negligible risk	Structural Asbestos	Dismantle Asbestos protocols
Flooded Pit	Minor risk	Negligible risk	Negligible risk	Water quality Pit wall stability	Isolate from L. Athabasca No mitigation (Egress exists)
Waste Rock Piles	Minor risk	Negligible risk	Negligible risk	Seeps Radiation	Not impacting L. Athabasca Cover areas of elevated gamma
Gunnar Main Tailings	Moderate risk	Moderate risk	Negligible risk	Surface water quality Radiation Radon Dusting	Post warning signs Conduct human and ecological risk assessment Cost/benefit analysis of potential mitigation options required
Gunnar Central Tailings	Moderate risk	Moderate risk	Negligible risk	Surface water quality Radiation Radon Dusting	Post warning signs Conduct human and ecological risk assessment Cost/benefit analysis of potential mitigation options required
Langley Bay Tailings	Minor risk	Moderate risk	Negligible risk	Radiation Radon Dusting	Post warning signs Conduct human and ecological risk assessment Cost/benefit analysis of potential mitigation options required
Back portion Langley Bay	Moderate risk	Negligible risk	Negligible risk	Water quality	Not impacting L. Athabasca
Langley Bay Proper	Negligible risk	Negligible risk	Negligible risk	Water quality Consumption of Fish	Not impacting L. Athabasca Post 'Alerts' (as per 2003)

No risk < Negligible risk < Minor risk < Moderate risk < Significant risk

3.6 Due Diligence Investigation

In 2001, the Contaminated Lands Evaluation and Assessment Network (CLEAN) Program was established by the Canadian Nuclear Safety Commission to deal with sites previously not licensed by the *Atomic Energy Control Act*, but which now must be licensed pursuant to the *Nuclear Safety and Control Act* (NSCA) (CNSC, 2001). One category of such sites includes tailings management sites resulting from the former operation of uranium mines. Documentation prepared by CNSC staff states:

> *"some of these tailings management sites were previously exempted from licensing because they are in the care and control of provincial or federal government agencies, and the Atomic Energy Control Act was not binding on the Crown. Others were not licensed because their operational lives ended before the Atomic Energy Control Board began exerting regulatory control on the uranium mining industry."* (CNSC, 2001).

CNSC staff also state that the Gunnar and Lorado sites are considered abandoned and that the care and control of the sites has reverted to the Province of Saskatchewan (CNSC, 2001). Based on this, CNSC staff have requested that the Province of Saskatchewan bring a license application to the Commission or a Designated Officer for decision by December 31, 2004.

The Government of Saskatchewan is currently conducting a detailed investigation of the legal disposition of the Gunnar Mining Limited site to ascertain whether a successor to Gunnar Mining Limited still exists. In support of this work, the Province has requested additional information from the federal government with respect to contracts that existed between Gunnar Mining Limited and Eldorado Mining and Refining Ltd., as mining Permits, MP2/54 (September 16, 1954 by the Atomic Energy Control Board) and MP 2/57, (February 1, 1957 by the Atomic Energy Control Board) specified that Gunnar Mining Limited was authorized:

> *"to carry on development, mining, milling and concentrating operations on the property hereunder mentioned and to ship ore and/or concentrates there from to Eldorado Mining and Refining Limited (hereinafter called "Eldorado") in accordance with such arrangements as may from time to time be in effect between you and Eldorado."*

To complete the necessary due diligence related to the Gunnar site and to ensure that all responsible parties are engaged in any future actions that may be required at the site, the Government of Saskatchewan has also requested the Canadian Nuclear Safety Commission's cooperation in facilitating the Province's access to AECB/CNSC files related to the former Gunnar and Lorado mine/mill sites.

4.0 SUMMARY OF CONCLUSIONS

4.1 Lorado Uranium Mining Ltd. Mill Site

The Government of Saskatchewan has conducted a detailed investigation of the legal disposition of the Lorado mill site in order to fulfill necessary due diligence requirements. During the course of this investigation, Saskatchewan conducted a title search of the property. That search disclosed that in 1970 title to the property was granted to International Mogul Mines Limited, a successor of Lorado Uranium Mining Ltd. A copy of that title, and the current titles registered in the name of Conwest Exploration Company Limited, a successor to International Mogul Mines Ltd., is set out in Appendix A. Conwest Exploration Company Limited was succeeded by AEC West Ltd. which changed its name to EnCana West Ltd. A copy of the Alberta Search Corporate Registration System search results and an extract from EnCana's website is attached in Appendix B.

The owner of the Lorado mill site is not the Government of Saskatchewan but EnCana West Ltd.

Furthermore, in undertaking the required due diligence investigation of both the company (Lorado) and the operations of its mill, confirmation that ore owned by Eldorado Mining and Refining Ltd. was milled at the Lorado Uranium Mining Ltd. mill was uncovered. A review of historical records has, to date, identified two ore bodies owned by Eldorado Mining and Refining Ltd. that were milled at the Lorado mill and hence contributed to the tailings currently existing at the Lorado mill site.

Prior to 1944, Eldorado Mining and Refining Ltd. was a privately held corporation, incorporated under the laws of Ontario. However, on January 28, 1944, by Order-in-Council PC535, it became a federal Crown corporation, incorporated under the *Dominion Companies Act (1934)* (Bothwell, 1984). Therefore, at the time the ore from Eldorado was being processed at the Lorado mill, Eldorado Mining and Refining Ltd. was a federal Crown corporation.

Based on this information, Saskatchewan believes that the CNSC staff's request that the Province of Saskatchewan bring a license application for the Lorado Uranium Mining Ltd. mill site to the Commission for decision by December 31, 2004 is misdirected.

Saskatchewan suggests that the Canadian Nuclear Safety Commission pursue EnCana West Ltd. as owner of the Lorado mill site. In addition, Saskatchewan suggests that the Canadian Nuclear Safety Commission and/or Environment Canada pursue the Government of Canada to address the wastes created at the Lorado site by the custom

milling of ore from Eldorado Mining and Refining Ltd. The milling of Eldorado ore at the Lorado site also contributed to the generation of the tailings that are currently the subject of the licensing action by the CNSC.

4.2 Gunnar Mining Limited Site

The facilities at the Gunnar Mining Limited site were constructed during the late 1950s and abandoned by the company in 1964. No maintenance has taken place on any of the facilities since the operation ceased and the natural processes of time have made a number of the existing buildings unsafe. Since 1964, salvage of equipment such as the leach tanks, all components of the crushing circuit, the entire powerhouse and its contents, as well as various wooden buildings and building parts has also taken place.

Generally, the site is in a shape that would be expected of a mine that has been abandoned for approximately 40 years. Originally, construction specifications provided very stable buildings and many still appear structurally sound today; however, others such as the head frame, mill and acid plant are not. Scavenging and some vandalism is evident in a number of buildings. This has had varying levels of effect on the structural integrity of some buildings.

Asbestos was used extensively in the construction and insulation of the majority of the facilities at the Gunnar site. This was confirmed in earlier investigations conducted on the site and in follow up laboratory verification.

Generally, the Gunnar Mining Limited site does not exhibit gamma radiation levels that would constitute a serious concern for casual site visits. None of the areas of the site present gamma measurements at a level that would warrant special precautions to guard against gamma radiation over a short time period. However, persons visiting the site should avoid excessive inhalation of contaminated dust and should observe general industrial hygiene practices; hands should be washed before eating and coveralls should be worn to protect under-clothing from picking up contaminants.

In August-September 2003, the Government of Saskatchewan completed a number of activities at the Gunnar Mining Ltd. site designed to limit casual access to the mill building, the bulk ore storage building near the mill, the acid plant, the head frame, community centre and bulk storage tanks.

During the same time, a total of 50 (fifty) 4 ft. x 8 ft. coroplast signs were installed at various locations throughout the Gunnar Mining Ltd. site to warn casual visitors to the site of the danger posed by radiation, asbestos and the unsafe structural condition of the buildings. Signs were placed on the head frame (4), the mill (14), acid plant (6), tailings

area access routes (2), as well as in seven other areas of access to the site itself and on other non-production facilities located on the site.

In addition, representatives of the Government of Saskatchewan have attended a number of fora in 2002 and 2003 in order to inform people, particularly residents of the area, of the risks posed by abandoned mines in the north. Letters warning local outfitters to avoid the sites and to report all activities on the site were issued in February 2003.

Water quality monitoring data (2002) from Langley Bay indicates that the concentrations of all parameters are below the Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life and relevant CCME water quality guideline values. In addition, the uranium concentrations within the bay waters are below both the federal and provincial recommended drinking water quality value in spite of the presence of tailings within the bay.

Monitoring data (1993) from 1 m off shore at three strategic locations (off the flooded pit, off the waste rock piles and off Langley Bay) indicate that the Gunnar Mining Limited site is having no measurable impact on the water quality of Lake Athabasca.

In 2002, the flooded Gunnar pit, which is physically isolated from Lake Athabasca, was found to contain a good diversity of aquatic biota, in a number of groups (phytoplankton, zooplankton, benthic invertebrates, and macrophytes), as well as a self-sustaining population of northern pike (CanNorth, 2002).

The Government of Saskatchewan will complete the required due diligence investigations related to the Gunnar Mining Limited property. Should these investigations result in the identification of a third party responsible for the Gunnar site, these findings will be brought for discussion with the CNSC in order to determine appropriate next steps to be taken to ensure progress toward the desired decommissioning of the Gunnar site.

As a contingency to a failure to identify any third parties responsible for the Gunnar site, Saskatchewan will continue to assemble, subject to budget appropriation, the necessary information required for the preparation of an application for a licence as specified by the *Nuclear Safety and Control Act*. In addition, and notwithstanding the final results of Saskatchewan's due diligence investigations of the Gunnar property, the Government of Saskatchewan will also continue efforts to re-engage the Government of Canada in meaningful negotiations to conclude a partnership-based agreement on the federal government's commitment of appropriate funding to support the proposed remediation of the former Gunnar and other smaller satellite uranium mine/mill sites in the Athabasca region.

However, the Government of Saskatchewan ***does not*** anticipate submitting an application for a license, under the *Nuclear Safety and Control Act,* to address the Gunnar property, until such time as it has secured a commitment from the Government of Canada to

provide an appropriate level of federal funding to complete the application, the decommissioning of the site and required transition phase monitoring.

In the interim, the Government of Saskatchewan will continue to monitor the Gunnar site and to assess, and address as required, any identified public safety and/or environmental risks.

5.0 SUMMARY OF FEDERAL/PROVINCIAL NEGOTIATIONS

5.1 Government of Saskatchewan's Position

The Government of Saskatchewan will complete the required due diligence investigations related to the Gunnar Mining Limited property. Should these investigations result in the identification of a third party responsible for the Gunnar site, these findings will be brought for discussion with the CNSC in order to determine appropriate next steps to be taken to ensure progress toward the desired decommissioning of the Gunnar site.

As a contingency to a failure to identify any third parties responsible for the Gunnar site, Saskatchewan will continue to assemble, subject to budget appropriation, the necessary information required for the preparation of an application for a licence as specified by the *Nuclear Safety and Control Act*. In addition, and notwithstanding the final results of Saskatchewan's due diligence investigations of the Gunnar property, the Government of Saskatchewan will also continue efforts to re-engage the Government of Canada in meaningful negotiations to conclude a partnership-based agreement on the federal government's commitment of appropriate funding to support the proposed remediation of the former Gunnar and other smaller satellite uranium mine/mill sites in the Athabasca region.

However, the Government of Saskatchewan ***does not*** anticipate submitting an application for a license, under the *Nuclear Safety and Control Act,* to address the Gunnar property, until such time as it has secured a commitment from the Government of Canada to provide an appropriate level of federal funding to complete the application, the decommissioning of the site and required transition phase monitoring.

In the interim, the Government of Saskatchewan will continue to monitor the Gunnar site and to assess, and address as required, any identified public safety and/or environmental risks.

The development and operations of early uranium mines and mills in northern Saskatchewan enabled Canada to supply uranium for the Cold War defence programs of that era. Given this history, the Government of Canada is being asked to commit to funding the cost of decommissioning and transition phase monitoring of former uranium mining and milling facilities in northern Saskatchewan, less any costs that governments are ultimately successful in having private entities bear.

This position is based on a number of important considerations including:

- The 1946 federal declaration of uranium as a strategic mineral under the *War Measures Act*;
- The historical federal monopoly over the mining, milling and sale of uranium and its refined products during the time that the northern Saskatchewan mines/mills were developed and operated (1950s and 1960s);
- Federal jurisdiction over the regulation of all uranium producing facilities in Canada through the use of its "declaratory power";
- The Government of Canada's foreign policy interest in supplying the end-user (U.S. "government programmes") with all uranium generated from northern Saskatchewan's 42 mines and/or mills;
- The United States' domestic program to cover the decommissioning costs of other abandoned uranium mine sites operating at the time; and
- Other international precedents.

A recent paper by the Saskatchewan Institute of Public Policy addresses, in more detail, these specific considerations (SIPP, 2003).

Uranium as a Strategic Mineral

At the time the Gunnar facilities were developed and operated, uranium was considered a strategic mineral, so the mining, milling and sales of uranium and its refined products were declared to be "works and undertakings for the general advantage of Canada."[1] While the Province of Saskatchewan generally has jurisdiction over mineral resources in the province, the federal government's declaration of uranium mining, milling and sales as being for the general advantage of Canada brought this sector under exclusive federal jurisdiction.

During the Second World War, the Government of Canada had a significant presence in the mineral sector, including uranium mining and milling, by virtue of the *War Measures Act*. At the end of the war, the federal government decided that, because of the strategic nature of the mineral and the associated issues of national and international security at the time, it would retain jurisdiction over the nuclear industry and that its jurisdiction would include the mining and milling of uranium. Consequently, in 1946, the federal government passed the *Atomic Energy Control Act*. This legislation declared that:

> *All works and undertakings whether hereto before constructed or hereafter to be constructed:*
>
> *(a) for the production, use and application of atomic energy,*
> *(b) for research or investigation with respect to atomic energy,*
> *(c) for the production, refining or treatment of prescribed substances,*

[1] *Constitution Act, 1867*, paragraph 92(10)(c).

> *are, and each of them is declared to be, works or a work for the general advantage of Canada (AEC, 1946).*

The validity of this declaration has been tested a number of times and, in each case, affirmed by judicial decision.

AECB Licensing

During the first 26 years of uranium development in Saskatchewan (1953 to 1979), the paramount regulatory authority overseeing uranium mining and milling in Canada was the federal Atomic Energy Control Board (AECB). At the time that the Gunnar Mining Limited and other facilities were constructed and operated, the AECB was the sole authority in Canada with the power to authorize the mining, milling and/or concentration of any and all radioactive substances including uranium ores. The AECB licensed both the Gunnar mine and mill to produce uranium; however, the AECB failed to impose decommissioning or reclamation criteria on any of the facilities when the company ceased operations in the early 1960s.

A review of historical records has revealed copies of AECB Exploration Permits MX2/53 (January 15, 1953) and MX24/53 (April 11, 1953) and Mining Permits MP2/54 (Sept. 16, 1954) and MP 2/57 (Feb. 1, 1957) issued to Gunnar Mines Ltd. At the time, AECB permits with the MP designation were authorizations:

> *to carry on development, mining, milling and concentrating operations on the property hereunder mentioned and to ship ore and/or concentrates there from to Eldorado Mining and Refining Limited (hereinafter called "Eldorado") in accordance with such arrangements as may from time to time be in effect between you and Eldorado.*

Eldorado Mining and Refining Ltd. – Federal Monopoly Over Uranium Trade

Prior to 1944, Eldorado Mining and Refining Ltd. was a privately held corporation, incorporated under the laws of Ontario. On January 28, 1944, by Order-in-Council PC535, it became a federal Crown corporation, incorporated under the *Dominion Companies Act (1934)*. (Bothwell, 1984) This action was authorized under the *War Measures Act*.

Coupled to this was a federal government Order-in-Council, in September 1943, appropriating to the Crown in right of Canada all radioactive substances on existing leases and banning all future private prospecting and staking for such materials on federal lands. The result was that Eldorado was the sole source of uranium in Canada. Virtually all of the uranium produced in Canada up to the early 1960s was sold to the United States

Atomic Energy Commission (USAEC), an agency of the United States government, for use by U.S. "government programmes" (i.e., national defence).

While, the 1943 federal Order-in-Council was cancelled in March 1948 and replaced by a new policy that restored the right to control prospecting, staking and even mining of uranium to the provinces, the *Atomic Energy Control Act* and the existence of the Atomic Energy Control Board ensured that the federal government continued to exercise ultimate authority over actual mine development decisions (Bothwell, 1984); the federal government continued to determine the circumstances in which uranium could be mined and milled. In addition, Eldorado Mining and Refining Ltd. continued to have absolute control over all export sales of uranium and its refined products from Canada. In essence, the federal government continued its monopoly over all uranium sales from Canada throughout the 1950s and until 1962, the last year that the USAEC guaranteed purchases from Canada (Bothwell, 1984).

As the demand for Canadian uranium increased throughout the 1950s and Eldorado Mining and Refining Ltd. did not have sufficient internal capacity to supply all the ore required by the U.S., the federal government (through Eldorado) actively assisted in the development of new "privately" owned mines. By 1957, there were seventeen uranium companies in Canada. Of the seventeen, only Eldorado was authorized to export uranium. As a consequence, all other uranium producers were required to supply all their uranium, whether milled or not, to Eldorado, which would then resell the uranium to the USAEC (Bothwell, 1984).

All of the former uranium mines and mills in northern Saskatchewan were developed and operated during this period. In each case, once an ore body had been found and "proven", the owner was required to approach Eldorado to negotiate the price and conditions of sale. For example, in 1953, Gunnar Mines Ltd. was required to negotiate and sign a contract with Eldorado before developing its ore body. That contract stipulated that Gunnar was to supply Eldorado with 8,100,000 pounds of U_3O_8 at $9.50 per pound between 1955 and 1960. The contract, as well as the permit issued to Gunnar Mines Ltd. by the AECB, stipulated that all uranium sales were to be made to Eldorado. In turn, Eldorado then signed a contract for the same quantity of uranium ore with the USAEC. This arrangement allowed Gunnar Mines Ltd. to raise the necessary funds to develop the mine and mill and to begin operations in 1955 (Bothwell, 1984).

As this example makes clear, no uranium mine or mill could have been developed without the support and express agreement of Eldorado Mining and Refining Ltd., on behalf of the federal government. Eldorado's sole *raison d'etre* at the time was to supply a significant proportion of the uranium and refined uranium products required by the government of the United States.

International Precedents for Federal Funding

In spite of the breadth and depth of federal involvement in the establishment and operation of these mining and milling sites the federal government has, to date, refused to provide the funds necessary to undertake the decommissioning and reclamation of these sites. Instead, it insists on claiming that it no longer has any legal responsibility for these sites. This is in contrast to the practices of other industrialized federations, where it is invariably national governments that fund the decommissioning and reclamation of abandoned uranium sites that were established to support defence programmes.

For example, in Germany, the federal government undertakes the decommissioning and reclamation of abandoned uranium mines, through the vehicle of Wismut GmbH. However, other mature federations also provide precedents. The most important of these is likely the United States as, during the time period under discussion, the Government of Canada, as part of its foreign policy, mined, milled and processed domestic uranium largely for a single purpose, to supply the U.S. government defence programme. As the United States also had domestic uranium suppliers, it is relevant to examine how the U.S. government has addressed the decommissioning and clean-up of abandoned uranium mining and milling facilities operated inside the U.S. for the same purpose, and during the same period, as the northern Saskatchewan facilities.

In the United States, the responsibility for decommissioning and restoring uranium mines and mills depends on the purpose for which the uranium was produced. As with Eldorado Mining and Refining Ltd. in Canada, the U.S. Atomic Energy Commission was the sole purchasing agent in the 1950s and 1960s for all uranium produced in the U.S. In the case of uranium mines and milling facilities that existed prior to 1970 and which were developed to supply uranium to the U.S. defence program, the U.S. government has assumed 90 percent or more of the costs of decommissioning and rehabilitating the abandoned facilities and associated tailings (Smith, 2002).

There are, in total, 26 "inactive" uranium mill sites that produced uranium solely for the U.S. government prior to 1970. Between 1975 and 1978, the U.S. Department of Energy and the Energy Research and Development Administration (successor agencies to the U.S. Atomic Energy Commission) completed studies of 22 of these sites. These studies determined that uranium mill tailings at these sites posed potentially significant health hazards to the public and that a program should be developed to ensure proper stabilization and disposal of the tailings. In response, the U.S. Congress enacted the *Uranium Mill Tailings Radiation Control Act* (UMTRCA) in November 1978. This Act provides funds for the clean-up and stabilization of uranium mill tailings at inactive uranium-processing sites and provided for the subsequent addition of two other sites to the original list of 22.[2] Thus, the cost of remedial action at the 24 inactive sites in the

[2] The remaining two sites, located in North Dakota, were not included at the request of the State government, which indicated that the sites pose minimal risk to the public and the environment and that the State legislature was unlikely to appropriate funds to cover the State's share of the cleanup cost.

U.S. listed in the UMTRCA is borne almost exclusively by the U.S. government, which had spent nearly $1.5 billion as of December 31, 1999 under the Uranium Mill Tailings Remedial Action Program (EIA, 2002).

While the 1978 U.S. legislation does not provide federal funds for remedial action on sites that were active at the time of the passage of the Act, two subsequent reports to Congress concluded that government assistance should be provided to licensees at such active sites that had a history of supplying the U.S. defence program (NEA, 1999). Thus, under Title X of the 1992 *Energy Policy Act*, the U.S. Department of Energy is required to reimburse licensees of active uranium or thorium processing sites that are currently undergoing decommissioning for remedial action costs attributable to mill tailings generated as a consequence of production to supply the U.S. government. Reimbursable remedial actions include, but are not limited to: groundwater restoration, treatment of contaminated soil, disposal of processing wastes, pollution abatement, mill and equipment decommissioning, site monitoring and administrative expenses.

Australia has also had to respond to environmental damages from, and risks of, abandoned uranium mines. As with Germany and the United States, the Commonwealth (federal) government has funded the Australian clean-up projects. In the South Alligator River valley of Australia there are a number of former uranium mines that date back to mining and milling activities in the 1950s and 1960s (Env. Aus., 2001). These mines were subject to a hazard reduction program in the early 1990s and the need for further rehabilitation is the subject of negotiations between Parks Australia (a federal department) and the Jawoyn Traditional Owners. The Commonwealth Government also undertook a programme of hazard reduction work at the South Alligator Mill in 1991 and 1992. In addition, it funded the rehabilitation of the Rum Jungle Creek South Mine in 1990-1991, though the rehabilitation was managed by the Northern Territory Department of Mines and Energy (NTDME).

More recently, during the dry season of 2000, a program of interim works was undertaken by Parks Australia North to manage exposed uranium mill tailings located in the southern district of the Kakadu National Park near Gunlom. The completion of the tailings clean up is being incorporated into a broader plan for rehabilitation of all former uranium mining related sites in the South Alligator River Valley. Parks Australia North is developing the plan in consultation with members of the Gunlom Land Trust (the Traditional Owners of the land), the Northern Land Council and the Northern Territory Department of Mines and Energy. The completion of the tailings clean-up will be a priority once the issues of site-specific standards for radiological protection and containment have been finalized with the regulatory agency, the Australian Radiation Protection and Nuclear Safety Agency.

5.2 Federal/Provincial Negotiations to Date

The Province of Saskatchewan made a public commitment in its April 1998 response to the recommendations of the Joint Federal/Provincial Panel on Uranium Developments in Northern Saskatchewan to:

> "*enter into negotiations with the federal government to secure federal cost-shared funding to clean up these sites over the next several years, beginning with the development of a detailed decommissioning and reclamation plan for both sites. The government will also ensure training and employment opportunities for northerners in the decommissioning and reclamation at these sites are optimized*" (Sask., 1998).

At that time, the provincial Cabinet directed Saskatchewan Energy and Mines and Saskatchewan Environment to negotiate a cost-sharing agreement with the federal government to cover the cost to rehabilitate the Gunnar and Lorado sites, the two largest and most widely known of the 42 abandoned sites now documented in northern Saskatchewan. Negotiations between Natural Resources Canada and Saskatchewan Environment on a Memorandum of Agreement (MOA) to cost-share the rehabilitation of these two sites were initiated in 1998. The objective of the MOA was to have both governments pay 50% of the $25 million estimated costs to rehabilitate the two sites. Despite concluding a seventh draft of the proposed MOA, by February 2000 negotiations had broken down.

In response to a Spring 2000 request of the then federal Minister of Natural Resources - the Honourable Ralph Goodale, and in an effort to reinvigorate negotiations on the MOA, Saskatchewan completed an assessment of all former uranium mine sites in northern Saskatchewan by mid-2002. In addition, Saskatchewan took the opportunity to investigate international precedents in funding the decommissioning and rehabilitation of post WWII era uranium facilities in other jurisdictions and found that, invariably, it is national governments that fund the decommissioning and reclamation of abandoned uranium sites that were established to support defence programmes.

Based on this assessment of its former uranium mine sites, Saskatchewan developed, in Fall 2002, an overall strategy by which to proceed toward the decommissioning and reclamation of northern Saskatchewan's former uranium mine and mill sites, subject to the federal government's confirmation of its funding commitment. This strategy was approved by the Saskatchewan Cabinet in January 2003 and its implementation has been guided by a steering committee of Deputy Ministers.

Initial discussions with a wide array of federal authorities (Privy Council Office, Human Resources Development Canada, Industry Canada, Western Economic Diversification, Indian and Northern Affairs Canada and the Saskatchewan Council of Senior Federal Officials), commencing in early 2003, revealed general interest in Saskatchewan's overall

proposal. Specific offers of support in implementing the proposed project delivery model have been received from Indian and Northern Affairs Canada and Western Economic Diversification permanent heads. This reflects their interest in collaborating with Saskatchewan to help realize the formation of a new 'northern partnership' company to undertake the proposed work – a new company that would meet the need for a competent authority to undertake the project, while at the same time setting the foundation for long-term benefits for northern residents from the project and related work. These same initial discussions also emphasized the need to ensure Natural Resources Canada's support for Saskatchewan's proposal.

Although informal contacts in April-May 2003 between provincial and NRCan officials suggested Saskatchewan's proposal was receiving 'generally positive' consideration, a late July 2003 conference call between Saskatchewan's Deputy Minister of Northern Affairs and his counterpart in NRCan revealed a range of federal concerns – Canada's uncertainty as to the priority Saskatchewan attached to the file, lack of direction from the NRCan Minister, the accuracy of a $30 million project cost estimate, the viability of the proposed project delivery model, and questions about federal responsibility and liability (precedent) if Canada were to contribute funding. In addition, provincial officials were also aware that the then Secretary of State for Western Economic Diversification had also raised, in a letter to the Northern Saskatchewan Environmental Quality Committee, the need for first undertaking a national 'site risk' assessment inventory, before Canada would be able to respond to Saskatchewan's specific request.

In response to follow-up Saskatchewan letters sent in August 2003 to press the question of Canada's funding commitment to the proposed project, the then Minister and Deputy Minister of Natural Resources Canada both offered similar responses in their September 2003 replies to their Saskatchewan Northern Affairs' counterparts. NRCan expressed the view that Saskatchewan, as the owner of the sites, was responsible for their management and clean-up. While acknowledging the commitment, in the February 2003 federal budget, of federal contaminated site funding to address those sites where the federal government made a direct contribution to the contamination, the letters indicated however that no federal funds were available to assist the Province in the proposed clean-up project.

With provincial election, federal governing party leadership and federal Cabinet questions now settled in the fourth quarter of 2003, and additional results emerging from Saskatchewan's due diligence work surrounding the Gunnar and Lorado sites, Saskatchewan looks forward to re-engaging senior federal officials in discussing Canada's required role and financial support for the proposed project.

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Sa Majesté la Reine du chef du Canada, Ressources naturelles Canada.

Study Area

Figure 2.1.1

Figure 2.1.2
Lorado Uranium Mining Ltd. Mill Location

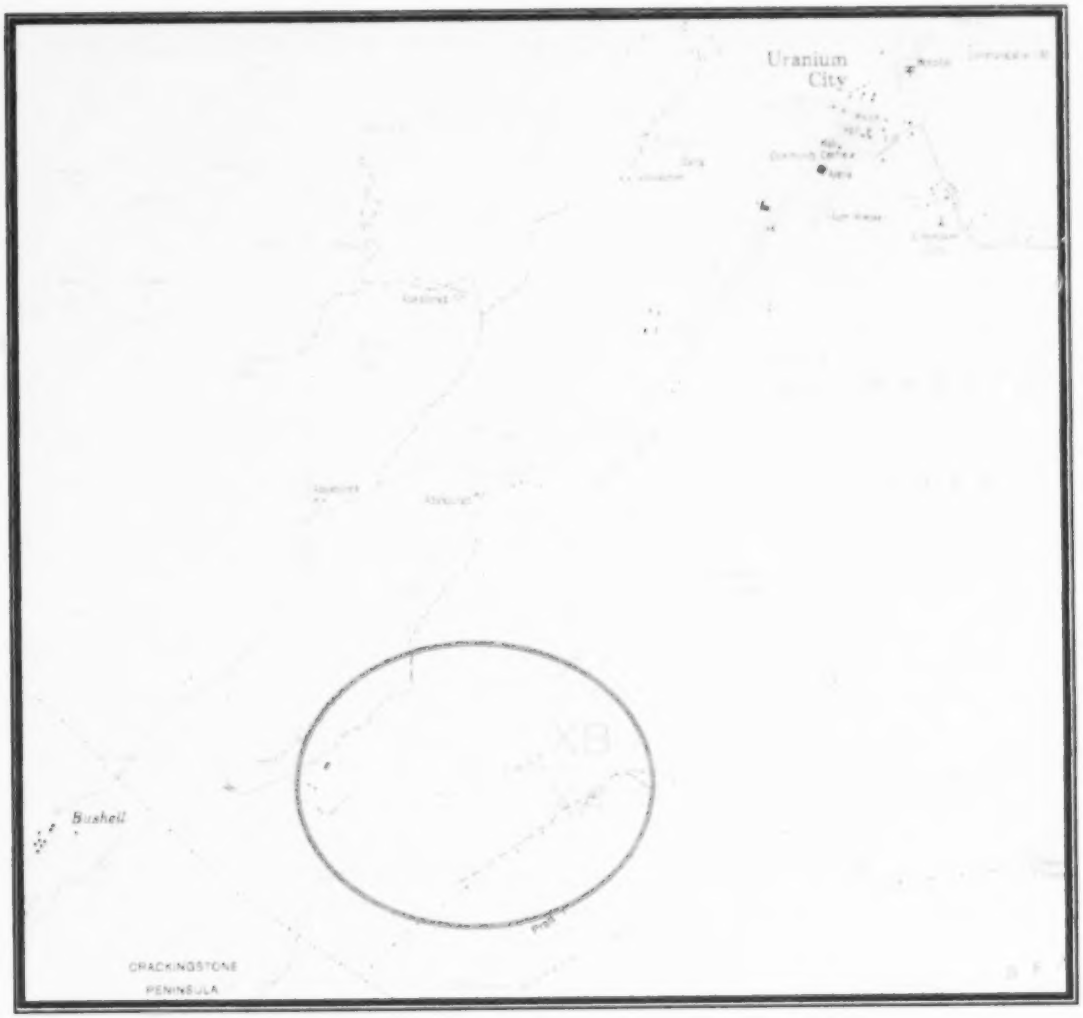

Figure 2.1.3
Lorado Uranium Mining Ltd. Mill Location

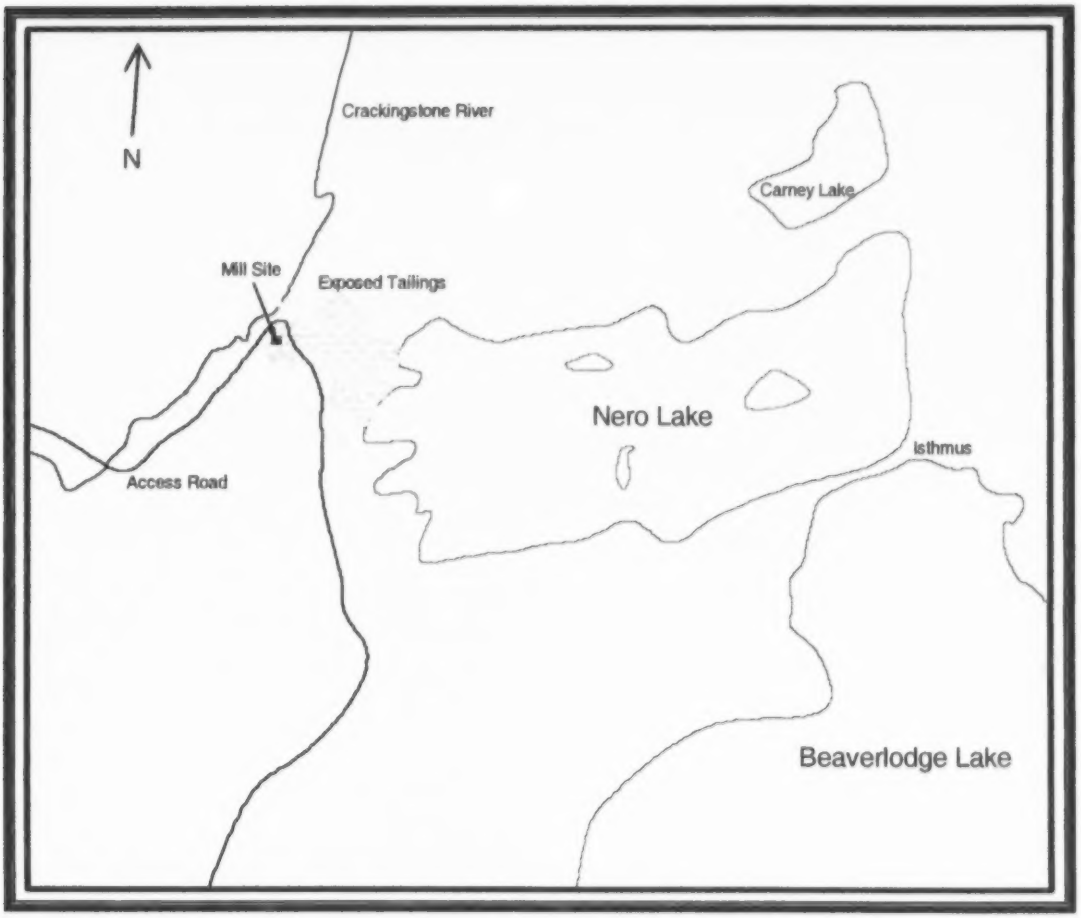

Figure 2.1.4
Lorado Uranium Mining Ltd. Mill Site

Figure 3.1.2
Gunnar Mining Limited Location

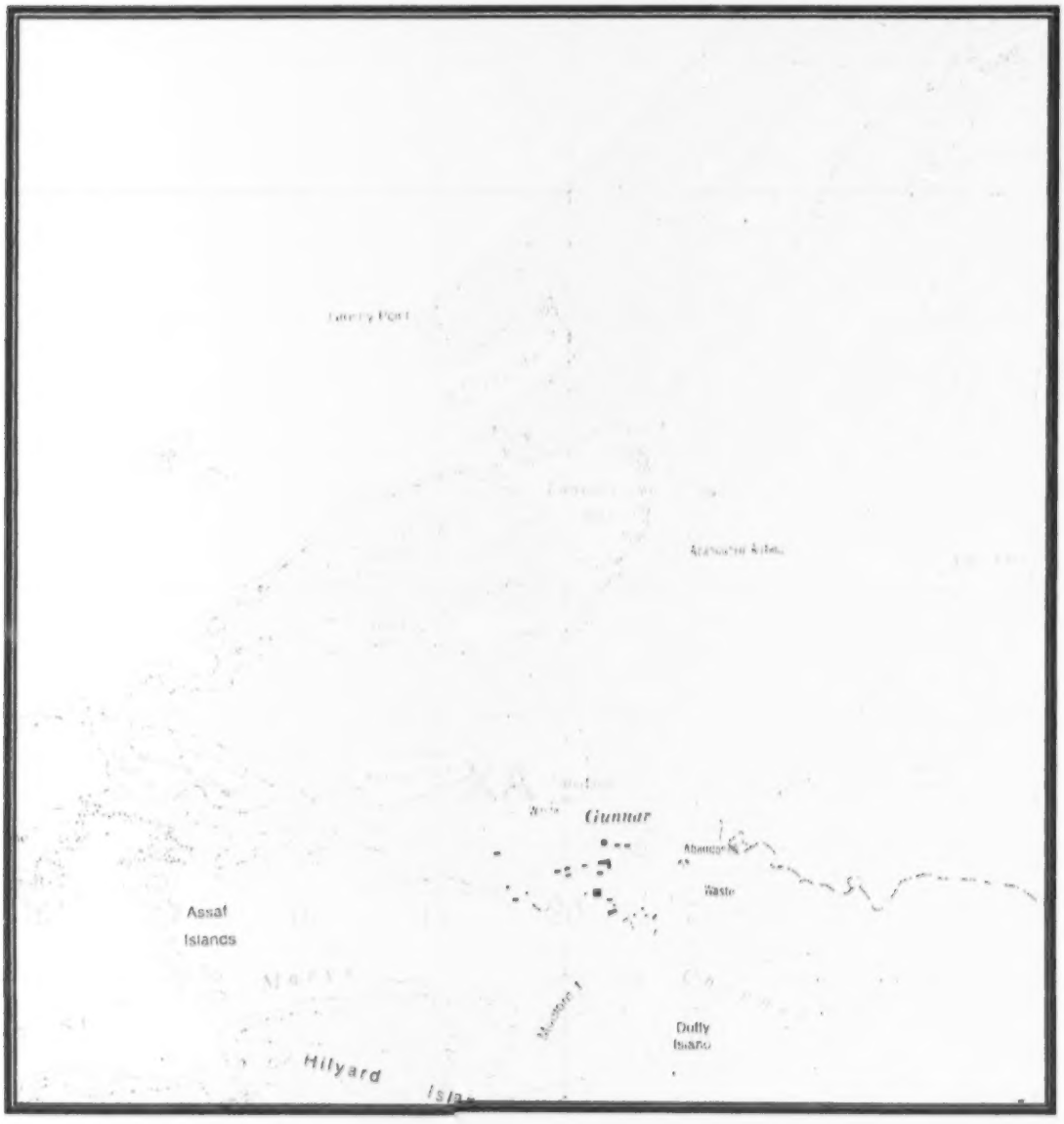

Figure 3.1.3
Gunnar Mine Limited Facilities

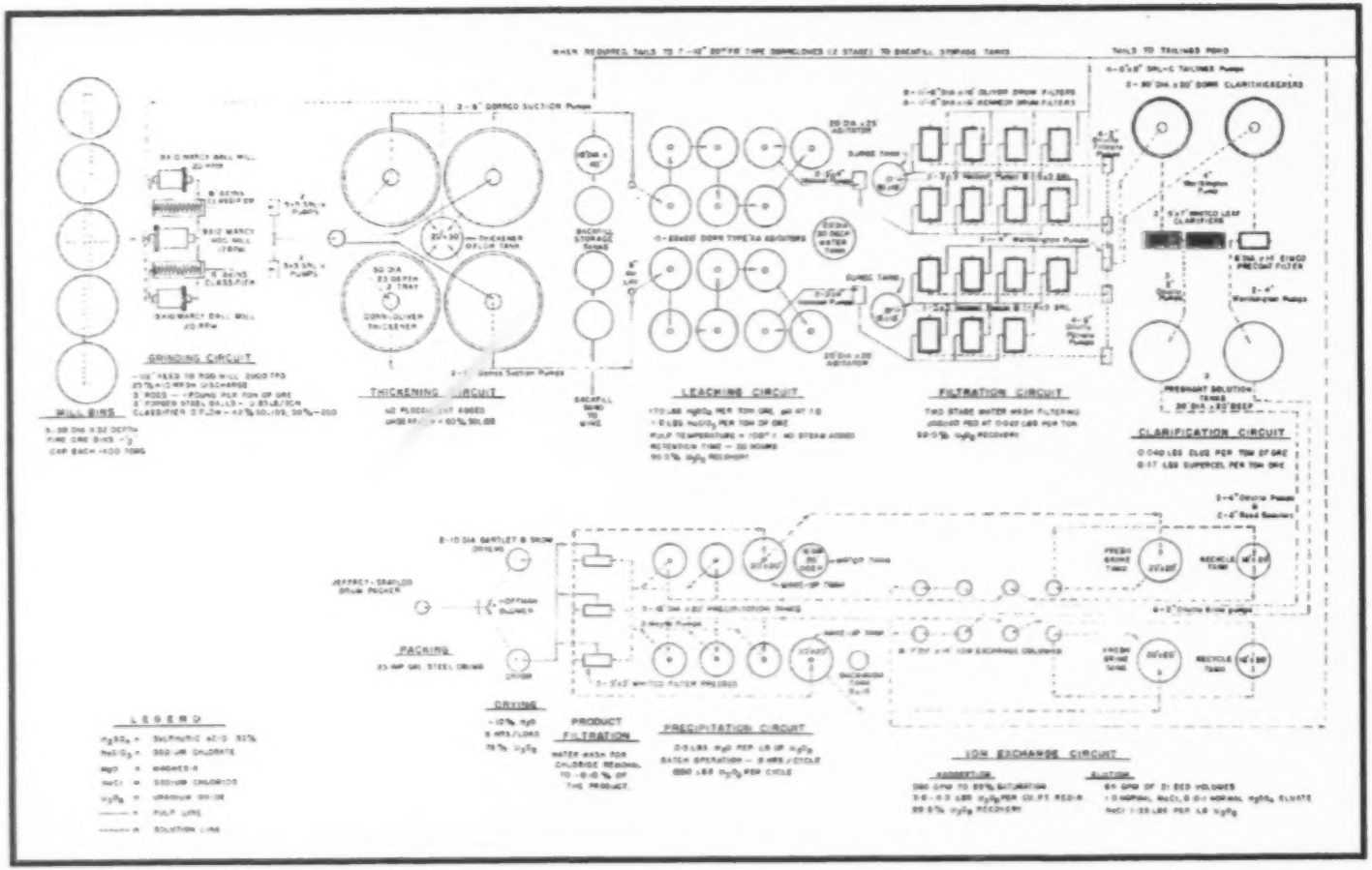

Figure 3.2.1
Gunnar Mining Limited Mill Circuit

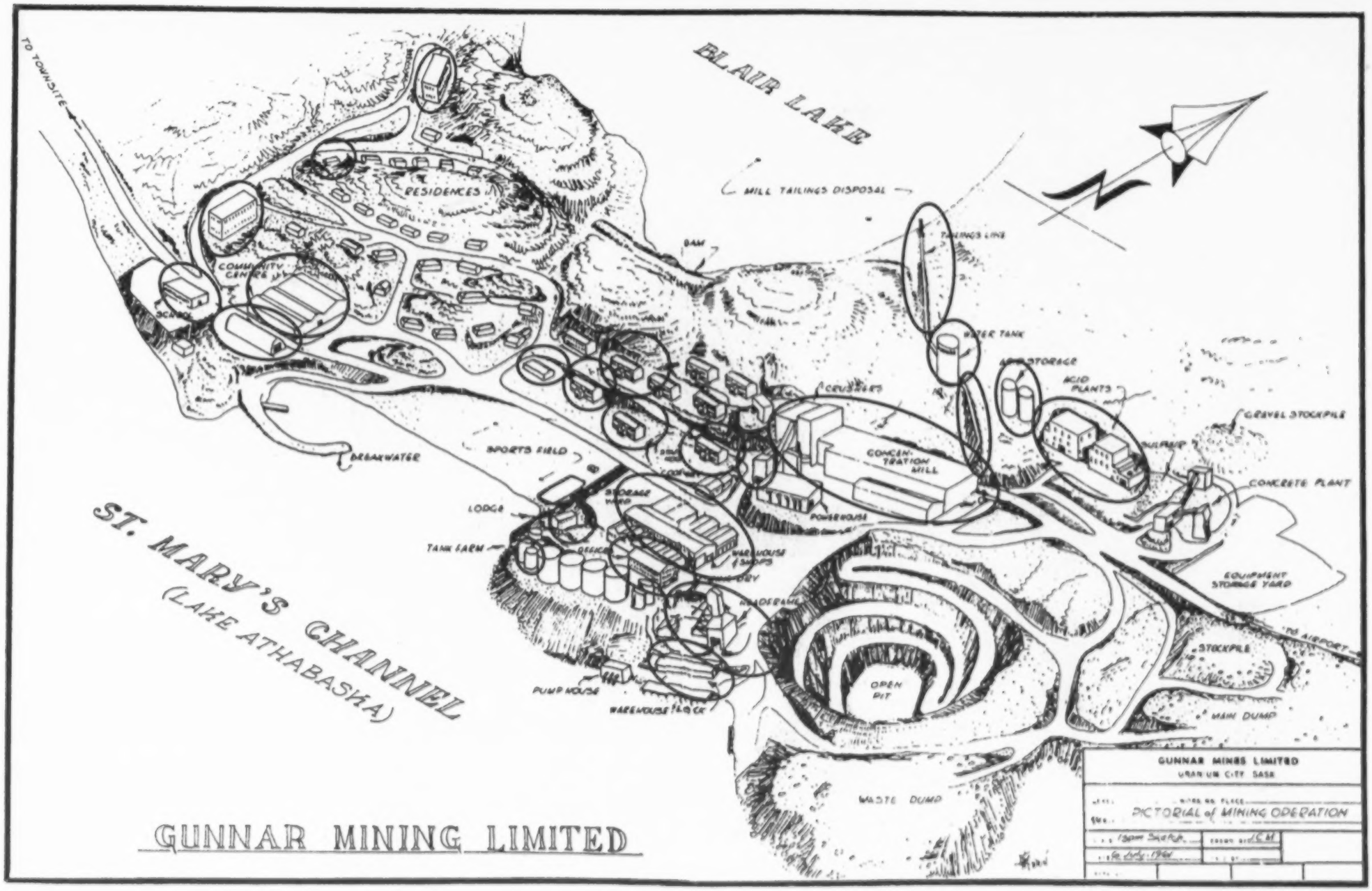

Figure 3.3.1
Existing Facilities

#	Description
1	Headframe
2	Mill
3	Acid Plant
4	Pumphouse
5	Geology/Mine Dry
6	Office/Engineering
6B	Maintenance Shop
7	Warehouse
8	Apartment Housing
9	Apartment Housing
10	Cold Storage
11	Community Centre
12	Curling Rink
13	School
14	Sewage Treatment
15	Married Apartments
16	Married Apartments
17	Pump Shed
18	Concrete Basement
19	Apartment Housing
20	Apartment Housing
21	Cabins
22	Cabins
23	Barge
24	Lodge
25	Tailings Pipeline
26	Acid Storage Tanks
27	Water Tank

- Existing Structures

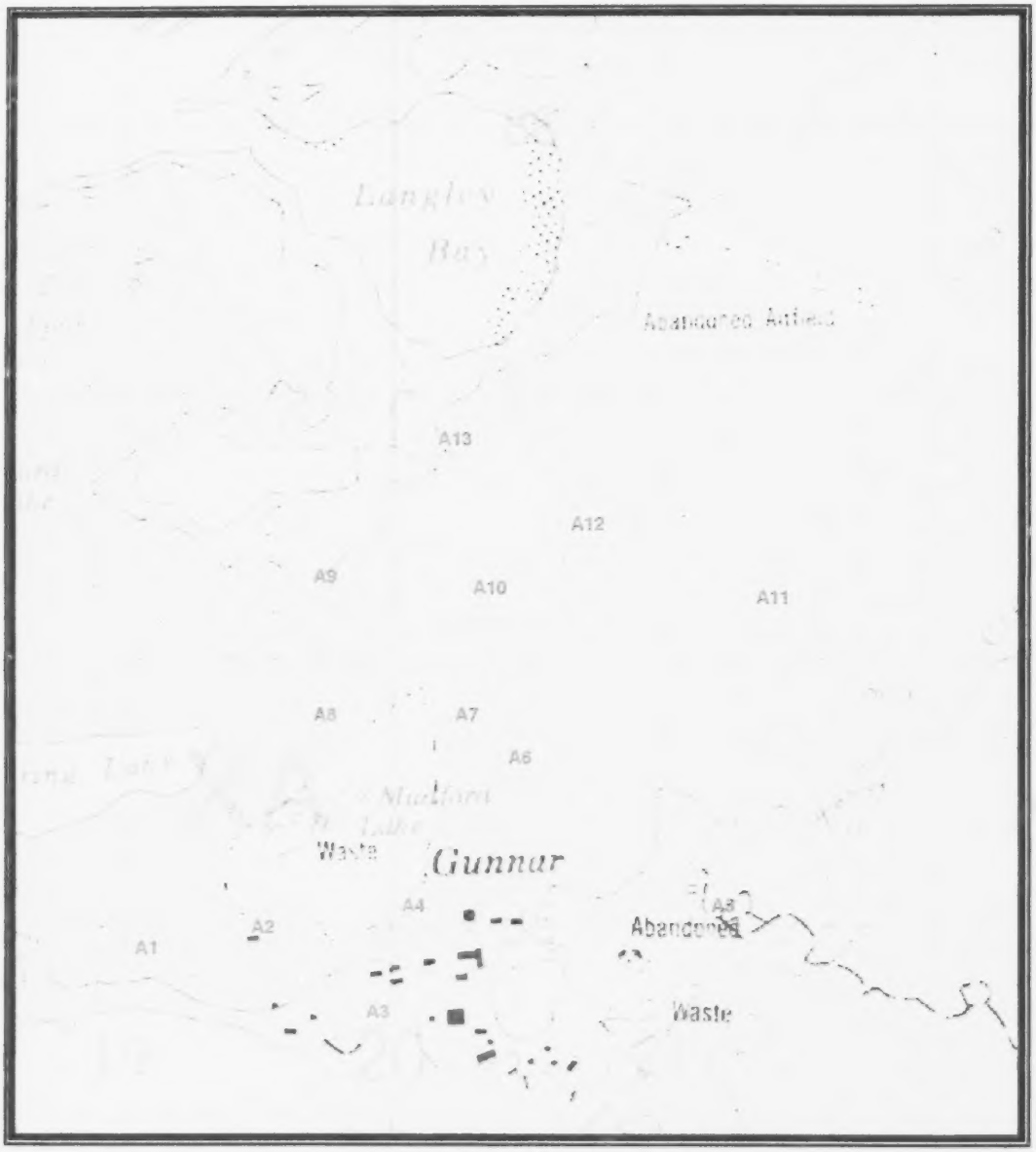

Figure 3.3.2
Ambient Radon Sampling Sites
(BBT, 1986)

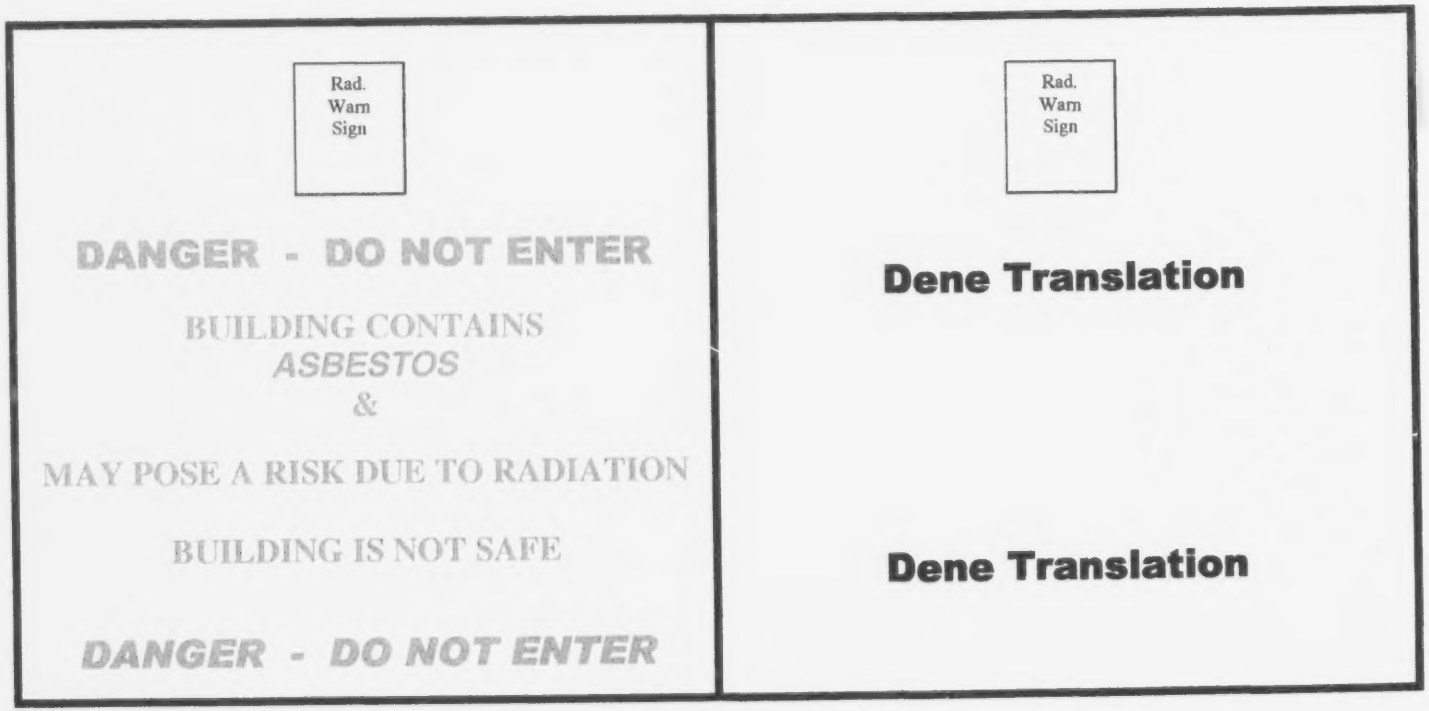

Figure 3.5.1
Mock-Up of 2003 Signage Posted
Gunnar Mining Ltd. Site

Tables 3.2.1
Production Data – Gunnar Mining Limited
(Source: Company Annual Reports)

Year	*Daily Production (Tons of Ore Treated)*	*Mill-Head Grade (% U3O8)*	*Annual Production (Tons of Ore)*
1956	-	*0.191*	*451,632*
1957	*1.647*	*0.178*	*601,262*
1958	*1.95*	*0.188*	*711,298*
1959	*1.975 (approx)*	*0.184*	*719,785 (approx)*
1960	*1.942*	*0.185*	*710,785*
1961	*2.039*	-	*744,227*
1962	*2.155*	-	*786,481*
1963	*1.848*	-	*769,000*

Table 3.3.1
Gunnar Flooded Pit – Surface Water Quality

Analyte	*Unit*	*1978 (July)*	*1981 (Nov.)*	*2001 (Oct.)*	*2002 (Sept.)*
CO_3	mg/L	-			
Ca	mg/L	30	34		42
Cl	mg/L	6.0	-	6	<1
HCO_3	mg/L	-	70		88
K	mg/L	-	2.8	2.8	2.6
Na	mg/L	-	6.1	6.4	6.2
SO_4	mg/L	66	74	100	96
Sum of ions	mg/L	-	-		257
Tot. Harness	mg/L	-	-	170	161
C, total org.	mg/L	8	3		3.4
C, total	mg/L	17.5	-		20
N, Ammonia	mg/L	0.06	-	0.02	<0.01
N, NO_3 Only	mg/L	<0.01	-		<0.01
N, total Kjeld.	mg/L	0.57	0.72		0.26
P, total as P	mg/L	-	1.3	0.08	<0.01
B	mg/L	-	-	0.036	0.033
Se	mg/L	<0.001	<0.001		<0.001
Ag	mg/L	-	-	<0.001	<0.001
Al	mg/L	-	0.12	0.24	<0.005
As	µg/L	<0.5	1.6	<0.5	0.9
Ba	mg/L	-	0.061	0.035	0.028
Be	mg/L	-	-	<0.001	<0.001
Bi	µg/L	-	-		<1
Cd	mg/L	<0.002	0.0018	<0.001	<0.001
Co	mg/L	-	0.002	<0.001	<0.001
Cr	mg/L	-	0.008	<0.001	<0.001
Cu	mg/L	<0.02	0.003	0.002	0.001
Fe	mg/L	-	0.044	0.20	0.004
Mg	mg/L	-	10	14	13
Mn	mg/L	-	0.014	0.035	0.004
Mo	mg/L	<0.02	<0.005	0.004	<0.001
Ni	mg/L	<0.03	0.003	0.005	<0.001
Pb	mg/L	<0.005	0.018	<0.002	<0.002
Si	mg/L	-	-	0.92	0.08
Sr	Mg/L	-	-	0.22	0.2
Ti	mg/L	-	-	0.001	<0.001
V	mg/L	<0.1	-	<0.001	<0.001
Zn	mg/L	<0.01	0.009	0.007	<0.005
Zr	mg/L	-	-	<0.001	<0.001
TSS	mg/L	6	175	17	240
Sp. conduct	µS/cm	430 umhos	-	374	354
pH	units	9.5	-	7.6	8.15
^{210}Pb	Bq/L	-	0.12	0.11	<0.02
^{210}Po	Bq/L	-	-	-	0.005
^{226}Ra	Bq/L	0.15	0.09	0.27	0.22
^{230}Th	Bq/L	-	0.06	0.04	<0.02
U, total	µg/L	-	708	720	863

1978 – Ruggles et.al 1981 – Tones 2001 – Saskatchewan Environment 2002 - CanNorth

Table 3.3.2
Summary Result of Ambient Radon Data (pCi/L) – Gunnar Mining Ltd. Site
(BBT, 1986)

Site Number	Dec/May	May/June	June/July
A1	0.94	5.72	6.69
A2	1.37	3.11	8.39
A3	2.21	4.42	8.39
A4	2.68 (2.27)	6.72 (4.23)	10.36 (3.86)
A5	0.75	4.69	12.48
A6	8.39	15.58	23.92<
A7	0.48	3.93	6.06
A8	0.41	9.26	9.27
A9	0.32 (0.34)	0.13 (3.83)	6.33 (5.26)
A10	0.38	3.36	7.26<
A11	0.40	3.93	6.86<
A12	0.33	1.98	10.08<
A13	0.60	4.50	7.82
Exposure Time Range (Days)	139-151	52-55	35-39

< Damaged Monitoring Equipment
( ) Replicates

Table 3.4.1
Langley Bay Water Quality

Analyte	Unit	Centre of Bay 1993	Centre of Bay 1996	Centre of Bay 1999	Centre of Bay 2002	Tailings Beach 2002	Tailings Beach 2002	Back Bay 2001
CO_3	mg/L	-	<1	-	<1	<1	<1	
Ca	mg/L	16	8.4	11	12	67	26	56
Cl	mg/L	3.0	3.0	3.1	5	13	7	6
HCO_3	mg/L	53	32	-	37	131	61	
K	mg/L	1.1	0.8	0.8	0.7	2.3	1	
Na	mg/L	3.7	2.6	2.6	2.7	12	4.9	
SO_4	mg/L	18	8.0	12	17	174	74	166
Sum of ions	mg/L	102	57	-	79	223	192	
Tot. Harness	mg/L	68	32	41	47	286	126	170
C, total org.	mg/L	6.4	3.6	-	7.1	18	9.7	
C, total	mg/L	17	10	-	14	44	22	
N, Ammonia	mg/L	0.01	0.04	0.05	0.02	0.04	0.07	0.39
N, NO_3 Only	mg/L	0.11	<0.01	-		0.48	0.27	
N, total Kjeld.	mg/L	0.24	0.32	-	0.38	0.83	0.55	
P, total as P	mg/L	0.02	0.01	-	0.7	0.02	<0.01	
B	mg/L	<0.05	0.007	-	0.014	0.081	0.029	0.072
Se	mg/L	<0.001	<0.001	-	<0.001	<0.001	<0.001	
Ag	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/L	0.11	0.010	0.016	<0.005	<0.005	<0.005	<0.0051
As	µg/L	1.1	<0.5	<0.5	<0.5	1.6	0.5	8.1
Ba	mg/L	0.027	0.014	0.017	0.016	<0.001	<0.001	0.049
Be	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bi	µg/L	<5	<1	-	-	<1	<1	
Cd	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Co	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr	mg/L	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/L	0.004	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Fe	mg/L	0.16	0.093	0.19	0.039	0.068	0.046	1.1
Mg	mg/L	6.7	2.6	3.4	4.3	31	11	27
Mn	mg/L	0.097	0.005	0.009	0.006	0.017	0.008	0.14
Mo	mg/L	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	mg/L	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	0.004
Si	mg/L	2.3	1.7	1.5	1.5	1.7	1.4	5.8
Sr	Mg/L	-	0.062	0.062	0.059	0.19	0.091	0.18
Ti	mg/L	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
V	mg/L	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zr	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TSS	mg/L	1	<1	3	<1	<1	<1	9
Sp. conduct	µS/cm	164	87	101	118	590	288	525
pH	units	6.89	7.39	7.62	7.5	7.78	7.88	7.6
^{210}Pb	Bq/L	0.06	<0.02	0.11	<0.02	0.03	<0.02	0.32
^{210}Po	Bq/L	0.07	0.01	-	0.008	0.03	0.03	-
^{226}Ra	Bq/L	0.30	0.09	0.20	0.10	-	0.16	0.97
^{230}Th	Bq/L	0.05	0.03	0.15	0.03	0.02	0.04	0.34
U, total	µg/L	4	<0.5	2.0	1.5	16	5.0	26

Table 3.4.2
Summary of Applicable Water Quality Objectives

Parameter	*Units*	*SSWQO For the Protection of Aquatic Life*[2]	*SSWQO General Surface Water Quality Objectives*[3]	*Canadian Water Quality Guidelines for the Protection of Aquatic Life*[4]	*Saskatchewan Municipal Drinking Water Quality Objectives*[5]	*Guidelines for Canadian Drinking Water Quality*[6]
Ammonia, Total	*mg/L*	*1.23*[(A)]	-	*1.37 at pH 8.0:10°C* *2.20 at pH 6.5:10°C*	-	-
Arsenic	*mg/L*	*0.05*	-	*0.005*	*0.025*	*0.025*
Barium	*mg/L*	*1*	-	-	*1*	-
Cadmium	*mg/L*	*0.001*	-	$10^{[.86(\log(\text{hardness}))-3.2]}$	*0.005*	*0.005*
Chromium	*mg/L*	*0.02*	-	*Cr(III) 0.0089* *Cr(VI) 0.001*	*0.05*	*0.05*
Copper	*mg/L*	*0.01*	-	*0.002 at [$CaCO_3$]=0-120 mg/L* *0.003 at [$CaCO_3$]=120-180 mg/L* *0.004 at [$CaCO_3$] >180 mg/L*	*1*	*1*
Iron	*mg/L*	*1*	-	*0.3*	*0.3*	*0.3*
Lead	*mg/L*	*0.02*	-	*0.001 at [$CaCO_3$]=0.60 mg/L* *0.002 at [$CaCO_3$]=60-120 mg/L* *0.004 at [$CaCO_3$]=120-180 mg/L* *0.007 at [$CaCO_3$] >180 mg/L*	*0.01*	*0.01*
Mercury	*mg/L*	*0.0001*	-	*0.001*	*0.001*	*0.001*
Nickel	*mg/L*	*0.025* [(B)]	-	*0.025 at [$CaCO_3$]=0.60 mg/L* *0.065 at [$CaCO_3$]=60-120 mg/L* *0.110 at [$CaCO_3$]=120-180 mg/L* *0.150 at [$CaCO_3$] >180 mg/L*	-	-
PH	-	-	*6.5 – 8.5*	*6.5 – 9.0*	*6.5 – 9.0*	*6.5 – 8.5*
Radium 226	*Bq/L*	-	*0.11*	-	-	*0.6*
Selenium	*mg/L*	*0.01*	-	*0.001*	*0.01*	*0.01*
Silver	*mg/L*	*0.01*	-	*0.0001*	-	-
TDS	*mg/L*	-	-	-	*1500*	*500*
TSS	*mg/L*	-	*BkGd + 10*	-	-	-
Uranium	*mg/L*	-	-	-	*0.02 (Amended 2002)*	*0.02 (Amended 2001)*
Zinc	*mg/L*	*0.05*	-	*0.03*	*5*	*5*

2 *Saskatchewan Surface Water Quality Objectives for the Protection of Aquatic Life, 1995.*
3 *Saskatchewan Surface Water Quality Objectives – General Surface Water Quality Objectives, 1995.*
4 *Canadian Water Quality Guidelines for the Protection of Aquatic Life, CCME, 1999*
5 *Saskatchewan Municipal Drinking Water Quality Objectives, 1996.*
6 *Guidelines for Canadian Drinking Water Quality, Health Canada, 1996.*
(A) *Total ammonia criterion is for pH of 7.5 and a temp. ature of 20°C. Different criteria apply to other pH and temperature conditions.*
(B) *Applicable for hardness less than 100 mg/L (as $CaCO_3$). The objective is 0.1 mg/L for a hardness greater than 100 mg/L ($CaCO_3$).*

Table 3.4.3
Lake Athabasca – Surface Water Quality 1993

Analyte	*Unit*	*1 m off Langley Bay*	*Bushell Bay*	*1m off Waste Rock Piles*	*1 m off Flooded Pit*
CO_3	mg/L	-	-	-	-
Ca	mg/L	7.8	7.7	-	8.6
Cl	mg/L	8.3	3.4	2.0	3.7
HCO_3	mg/L	29	29	63	32
K	mg/L	6.4	0.9	1.6	1.0
Na	mg/L	2.8	2.9	2.1	3.0
SO_4	mg/L	3.9	3.8	6.0	4.2
Sum of ions	mg/L	61	50	96	55
Tot. Harness	mg/L	28	28	60	31
C, total org.	mg/L	3.0	2.9	7.3	3.2
C, total	mg/L	8.8	8.7	20	9.4
N, Ammonia	mg/L	0.01	0.01	0.01	<0.01
N, NO_3 Only	mg/L	0.10	0.04	0.06	0.03
N, total Kjeld.	mg/L	0.20	0.21	0.32	0.17
P, total as P	mg/L	0.01	0.02	0.02	0.02
B	mg/L	<0.05	<0.05	<0.05	<0.05
Se	mg/L	<0.001	<0.001	<0.001	<0.001
Ag	mg/L	<0.001	<0.001	<0.001	<0.001
Al	mg/L	0.063	0.018	0.065	0.69
As	µg/L	1.3	1.2	1.2	1.2
Ba	mg/L	0.011	0.011	0.043	0.012
Be	mg/L	<0.001	<0.001	<0.001	<0.001
Bi	µg/L	<5	<5	<5	<5
Cd	mg/L	<0.001	<0.001	<0.001	<0.001
Co	mg/L	<0.001	<0.001	<0.001	<0.001
Cr	mg/L	<0.001	<0.001	<0.001	<0.001
Cu	mg/L	0.001	<0.001	0.002	0.001
Fe	mg/L	0.037	0.011	0.014	0.015
Mg	mg/L	2.3	2.3	5.7	2.5
Mn	mg/L	<0.001	<0.001	0.002	<0.001
Mo	mg/L	<0.005	<0.005	<0.005	<0.005
Ni	mg/L	0.003	0.006	0.001	0.005
Pb	mg/L	<0.005	<0.005	<0.005	<0.005
Si	mg/L	1.5	1.4	1.1	1.7
Sr	Mg/L	-	-	-	-
Ti	mg/L	<0.001	<0.001	<0.001	<0.001
V	mg/L	<0.01	<0.01	<0.01	<0.01
Zn	mg/L	<0.005	0.02	<0.005	0.005
Zr	mg/L	<0.005	<0.001	<0.001	<0.001
TSS	mg/L	1	<1	4	<1
Sp. conduct	µS/cm	94	74	129	81
pH	units	7.29	7.25	7.24	7.32
^{210}Pb	Bq/L	<0.02	<0.02	<0.002	0.02
^{210}Po	Bq/L	0.03	0.02	0.04	0.04
^{226}Ra	Bq/L	<0.005	<0.005	<0.005	0.01
^{230}Th	Bq/L	0.4	<0.01	<0.01	0.02
U, total	µg/L	1.4	2.0	3.7	2.1

Table 3.4.4
Migratory Water Fowl Tissue Analysis

Muscle Tissue – Breast

Parameter	Units	Rabbit Lake				Cluff Lake		Gunnar Main Tailings	Langley Bay – Lake Athabasca
		Lesser Scaup Average (n=3)	Canada Geese Average (n=3)	Northern Pintail	Bufflehead	Canada Geese Average (n=2)	Mallard Average (n=2)	Immature Horned Grebe	Red-Breasted Merganser
Lead-210	Bq/g	<0.04	<0.04	<0.04	<0.04	0.00325	0.016	<0.004	<0.004
Polonium-210	Bq/g	2.97	0.00	0.28	0.09	0.122	4.3	0.14	0.046
Radium-226	Bq/g	<0.01	<0.01	<0.01	<0.01	0.00235	0.004	<0.001	<0.001
Uranium	µg/g	0.06	0.05	<0.02	0.03	0.0045	0.002	0.01	<0.002

Liver

Parameter	Units	Rabbit Lake				Cluff Lake		Gunnar Main Tailings	Langley Bay – Lake Athabasca
		Lesser Scaup Average (n=3)	Canada Geese Average (n=3)	Northern Pintail	Bufflehead	Canada Geese Average (n=2)	Mallard Average (n=2)	Immature Horned Grebe	Red-Breasted Merganser
Lead-210	Bq/g	<0.04	<0.04	<0.04	<0.04	0.029	0.150	0.59	<0.004
Polonium-210	Bq/g	19.33	0.04	2.7	0.29	2.67	34	0.9	0.34
Radium-226	Bq/g	0.02	<0.01	<0.01	<0.01	0.00615	0.25	<0.002	<0.001
Uranium	µg/g	3.13	0.13	0.23	<0.02	0.0043	0.095	0.05	<0.002

Kidney

Parameter	Units	Rabbit Lake				Cluff Lake		Gunnar Main Tailings	Langley Bay – Lake Athabasca
		Lesser Scaup Average (n=3)	Canada Geese Average (n=3)	Northern Pintail	Bufflehead	Canada Geese Average (n=2)	Mallard Average (n=2)	Immature Horned Grebe	Red-Breasted Merganser
Lead-210	Bq/g	0.04	<0.04	<0.04	<0.04	0.775	2.9	<0.1	0.2
Polonium-210	Bq/g	31.00	0.17	3.1	0.42	5.45	141	1.3	0.27
Radium-226	Bq/g	0.05	<0.01	0.01	<0.01	0.021	0.20	<0.04	<0.05
Uranium	µg/g	1.07	0.10	0.24	<0.02	0.00285	0.15	0.2	<0.3

Table 3.5.1
Gamma Measurements – Gunnar Mining Ltd. Site

Location	*1993 Saskatchewan Environment & Public Safety Gamma Measurements (μS/h) at 1 m*	*2003 CNSC Inspection Gamma Measurements (μS/h)*
Headframe (Building #1)	*1.0 at 1 m; 2.0 at surface*	-
Geology/Mine Dry (Building #5)	*1.0 Average*	-
Mine Engineering (Building #6A)	*0.5 Average*	-
Mechanical Shop (Building #6B)	*0.5 Average*	-
Cold Storage Building on Dock (Building #7)	*0.1 Average*	-
Haul Road – Head frame to mill	*1.5 Average*	-
Acid Plant (interior)	*0.1 Average*	-
Cold Storage Annex on Mill	*0.1 Average*	-
Yard immediately in front of Annex, Labs & Product Packaging Area	*2.0 Average*	*1.13 Average: Max. 4.48*
Fines Piles - Exterior of Ore Conveyor Annex	*5.0 at 1 m (7.0 at surface)*	*2.66 Average: 4.48 Max.*
Gunnar Mill	*See Table 3.5.2*	*0.79 Average: Max. 7.10*
Windblown Tailings South of Gunnar Main	*2.0 Average*	-
Tailings Line Spill Areas	*2.0 Max*	-
Gunnar Main Tailings	*3.0 Average*	*3.03 Average: Max. 7.11*
Gunnar Central Tailings	-	*2.29 Average: Max. 3.81*
Langley Bay Tailings	-	*4.67 Average: Max. 8.56*
Waste Rock Piles	-	*1.49 Average: Max. 6.13*

Table 3.5.2
Gamma Measurements – Gunnar Mining Ltd. Mill Building

Mill Location	*1993 Saskatchewan Environment & Public Safety Gamma Measurements (µS/h) at 1m*
Crushing Room	*1.0 Average*
4 m above floor in Ball-mill Area	*0.5 Average*
Ball-mill Area	*1.0 Average*
5 In-line Ore Bins	*1.0 Average*
Laboratory Area	*0.5 Average*
"Test Lab"	*0.5 Average*
String Filters (Individual filters have individual levels)	*5.0 - 12.0 at surface*
Eimco Filters	*3.0 Average*
Discharge Pipe from String Filters	*3.0 Average*
Residual Product - Packaging Area	*10.0 Average*
Product Chute - Packaging Area	*3.0 Average*
Product Storage Bin - Packaging Area	*1.0 Average*
1,000-ton Bin Annex	*1.0 Average*
Fines Piles - Exterior of Ore Conveyor Annex	*5.0 at 1 m - 7.0 at surface*

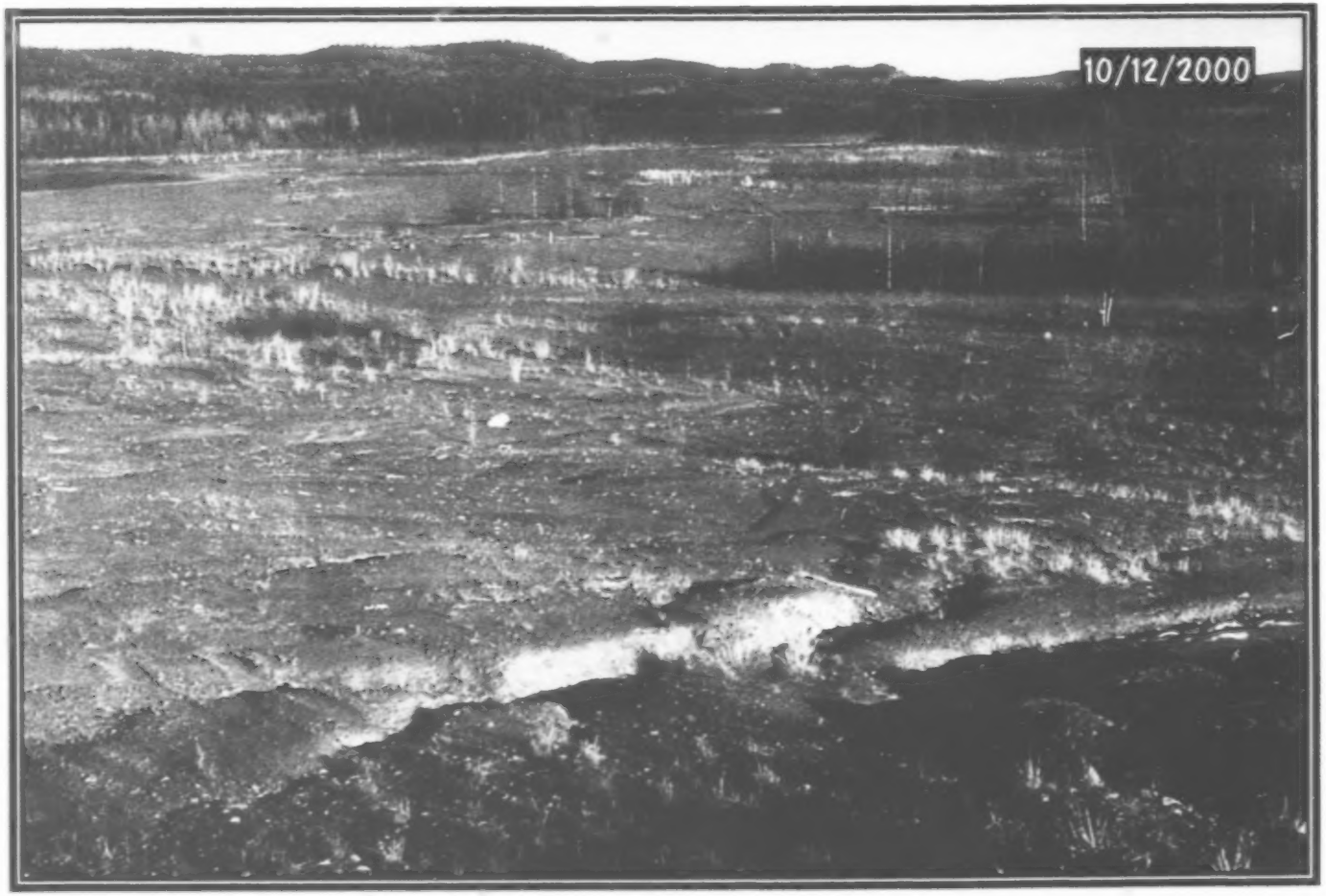

Plate 1 – Lorado Site (2000)

Plate 2 – Industrial Refuse Near Lorado Site (2001)

Plate 3 – Gunnar Mining Limited Site (2001)

Plate 4
Gunnar Mining Ltd. Open Pit (Circa 1962)

Plate 5
Warning Sign Gunnar Mining Ltd. Site

Plate 6
Closure and Warning Sign Head Frame

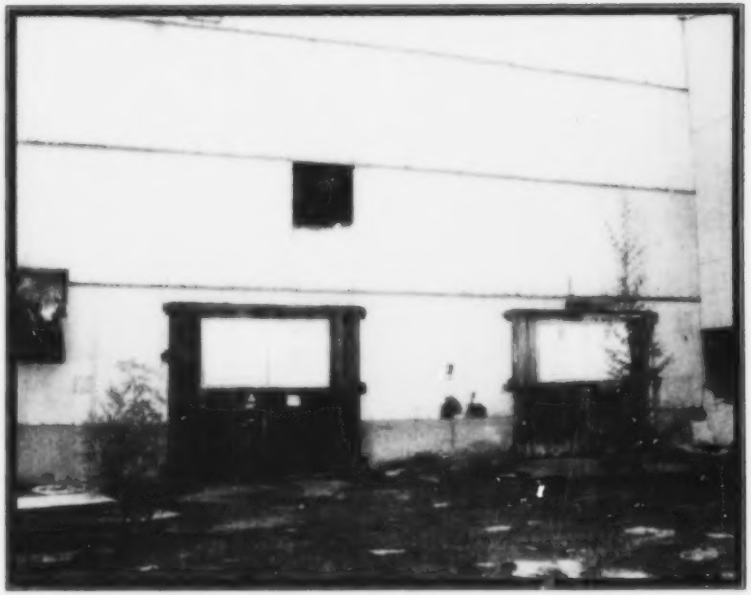

Plate 7
Closure and Warning Sign Mill

Plate 8
Free Standing Warning Sign Gunnar Main Tailings

Plate 9
Closure and Warning Sign Acid Plant